Anæsthetics

Ancient and Modern

George Foy

ANÆSTHETICS,

ANCIENT AND MODERN:

THEIR PHYSIOLOGICAL ACTION, THERAPEUTIC USE, AND MODE OF ADMINISTRATION;

TOGETHER WITH AN

HISTORICAL RESUME OF THE INTRODUCTION OF MODERN ANÆSTHETICS—NITROUS OXIDE, ETHER, CHLOROFORM, AND COCAINE;

And also an Account of the more Celebrated Anæsthetics in use from the Earliest Time to the Discovery of Nitrous Oxide.

BY

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TO

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THE "STONEWALL" JACKSON CORPS (2ND) ARMY OF NORTHERN VIRGINIA, C.S.A.,

WHOSE NUMEROUS, BRILLIANT, AND SUCCESSFUL OPERATIONS,

MANY OF WHICH WERE PERFORMED UNDER

GREAT DIFFICULTIES,

HAVE MADE HIS NAME HONOURED AND ESTEEMED IN

TWO HEMISPHERES,

THIS BOOK IS DEDICATED

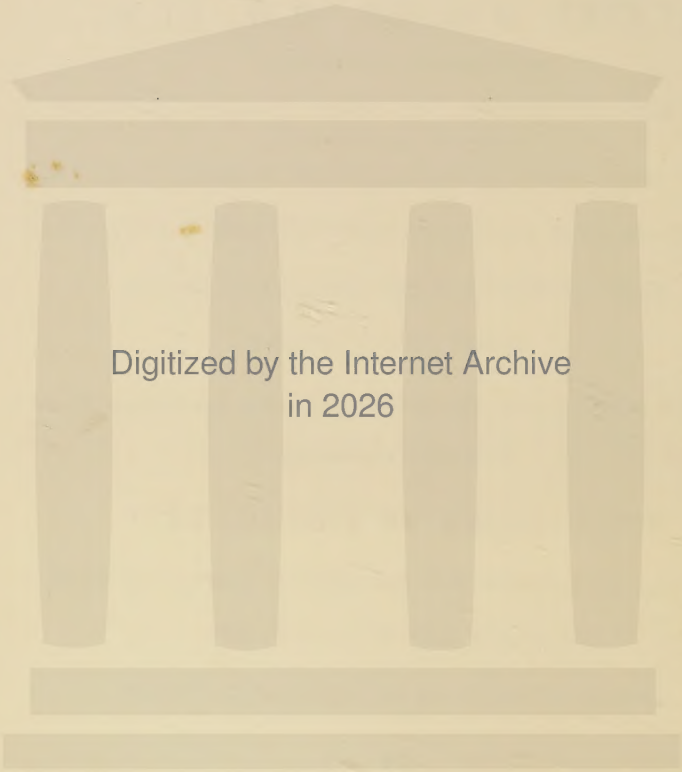
AS A MARK OF RESPECT FOR HIS GREAT ABILITY, AS BOTH A

MILITARY AND CIVIL SURGEON,

AND AS A TOKEN OF PERSONAL FRIENDSHIP,

BY

THE AUTHOR.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PREFACE.

THE greater part of the present volume, "Anæsthetics: Ancient and Modern," was contributed in a series of articles during the years 1888 and 1889, to the *Dublin Journal of Medical Science.*

In undertaking the work I was actuated by the wish not to rob the Moderns of those things which they have discovered or judiciously followed, and to render up those inventions which have been described by the Ancients to their rightful owners.

It is much to be regretted that many of the ablest and most original thinkers amongst English-speaking peoples—men who directly or indirectly have done much to promote medical science—are unknown, except to the few who find a pleasure in medical archæology.

Happily the existing indifference is disappearing. "The Early English Text Society" has rescued Vicary and Bullein from an undeserved obscurity, the classic pen of Dr. Richardson is familiarising his readers with the lives of the "Worthies" of medicine, and the "Reprints" of the Master of the Rolls has given us the works of Roger Bacon and "Saxon Leechdoms."

In the present history I have endeavoured to bring together, in a brief summary, the records of an almost forgotten past, that tell of the gradual evolution of the Anæsthetics of to-day from the first crude attempts of medicine among the ancients to find a pain-nullifier, in the days when the search was wholly empirical.

The history of anæsthetics naturally divides itself into three periods—to wit, the period of crude drugs, which lasted until the discovery of distillation, and was associated with superstition, often of a gross character; the period of distilled products, which lasted until the isolation of oxygen, from which event may be dated the third period, that of the inception of the discovery of modern anæsthetics.

These periods are not, however, sharply defined—they overlap. Thus, whilst scientific medicine uses modern anæsthetics, the medicine man of savage tribes still uses crude drugs and superstitious rites.

The reader will be gratified to find that modern anæsthesia, one of the greatest blessings of surgical science, is the outcome of the work and thought of English-speaking peoples.

In placing the advantages and disadvantages of the different anæsthetic agents before the reader, I have endeavoured to do so without prejudice. I prefer chloroform to the other anæsthetics, and I think that it has not latterly been as highly valued as its merits warrant. In the *Lancet* (Vol. II., 1888), I have so stated, but the fact that chloroform appears to me the most generally useful of anæsthetics, has

made me careful to place on record every fact that militates against its use. The cases quoted, of untoward effects from anæsthetics, were selected to show that unpleasant results, probably from idiosyncrasy, will occasionally occur—no matter what care is taken or what skill is exercised.

I have striven in every case, when making quotations, to give the author's own words and full references, so that the reader will have facilities for obtaining further information if he should feel so inclined.

The translations from Greek and Latin classics were made for me, from the most approved edition of the authors quoted, by my friend, Mr. William H. Brooks, Ex-Sch. T.C.D., to whom I am also indebted for his kindness in reading the final proofs. Those who know Mr. Brooks' ripe scholarship will not fail to appreciate how valuable such a contribution is from his pen.

Finally, "if in some things I dissent from others, whose wit, industry, diligence, and judgment, I look up at and admire, let me not, therefore, hear presently of ingratitude and rashness. For I thank those that have taught me, and will ever; but yet dare not think the scope of their labour and inquiry was to envy their posterity what they also could add and find out. If I err, pardon me. I do not desire to be equal with those that went before; but to have my reason examined with theirs, and so much faith to be given them, or me, as those shall evict. I am neither author or fautor of any sect. I will have no man addict himself to me; but if I have any thing

right, defend it as Truth's, not mine, save as it conduceth to a common good. It profits not me to have any man fence or fight for me, to flourish or take my side. Stand for truth, and 'tis enough."

80 Lower Gardiner-street,
August 25, 1889.

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ANÆSTHETICS.

"Oportet autem neque recentiores viros in his fraudare, quæ vel repererunt, vel recte secuti sunt; et tamen ea, quæ apud antiquiores aliquos posita sunt, auctoribus suis reddere."

CELSUS—*De Medicinâ.*

CHAPTER I.

Neglect of Anæsthetics in the Sixteenth Century—Mesmeric Anæsthesia—Greatrakes—Braid on Hypnotism—Mesmeric Treatment not unknown to the Greeks — Mandragora — Pliny — Homer — Dioscorides — Lucian — Galen — Avicenna and Averrhoes—Aëtius—Paulus of Ægina—Serapion—Celsus—Revival of Anæsthetic Treatment by Borde—Willis—Revolution due to Chemistry of the Moslems—Ugone da Lucca—Du Bartas—Anæsthetics in the Decameron.

MEDICAL historians have much difficulty in accounting for the disuse of anæsthetics at a time when medicine was making such marked progress, as it did under Cheselden, Smellie, and Sydenham. Nor do I find any mention of their use in the works of Thomas Vicary, who might fairly be supposed to know all the principal therapeutic agents of his day.

To-day we can hardly imagine why the preparation of anæsthetics was neglected, and it is still more strange, that surgeons of the repute of Paré and Wiseman are not credited with their use. An explanation—but one not wholly satisfactory[a]—may be found in the fact that anæsthesia was produced by "stroking" and the inunction of ointments, with which were associated charms and incanta-

[a] Sir James Young Simpson thinks the anæsthetics of the ancients were so uncertain in their effects that they had to be discontinued, and quotes Aretæus in support of his theory; but I can find nothing in the Sydenham Society's edition of the Cappadocian's works to warrant the conclusion.

tions, which latter were little calculated to receive favourable acceptance from men who sought to establish medical practice on a scientific basis. Its association with quackery discredited it.

Greatrakes,[a] the celebrated Irish "Stroker," was brought to England to treat Lady Conway, of Ragley, in Warwickshire, in 1661. He obtained notoriety for his supposed power as an anæsthetist, and was, in consequence, invited by the Earl of Arlington, at Charles II.'s command, to give an exhibition of his powers before that monarch at Whitehall. Greatrakes undertook the journey to England without expectation of office or reward; and after that he had been at the palace of Whitehall, where it does not appear he attracted much attention, he took up his abode in Lincoln's Inn Fields, "where incredible numbers of all ranks and sexes flocked to him, expecting the restoration of their health."

Mesmerism, as recorded by Mr. James Braid,[b] has proved a successful anæsthetic in many cases in India, in which country Dr. Esdaile[c] performed "upwards of three hundred capital operations of every description, and many of them of the most terrible nature, without inflicting pain on the patients, and in every instance the insensibility was produced in this fashion. Since Braid's time in France, indeed as early as 1829, Cloquet[d] ablated the breast of a woman who was under the anæsthetic influence of hypnotism, and Broca performed a very painful operation on the anus of a patient who was hypnotised without causing pain. It, however, has the tendency to produce hysterical affections, and some instances are on record of temporary, and even permanent, insanity following its use, of which untoward result Dr. Doneto's[e] patient is a well-

[a] Early Irish Mesmerists, by R. R. Madden, M.D., M.R.I.A.

[b] Hypnotism, by Mr. James Braid, M.R.C.S.

[c] Medical Press. Vol. CXLVII., p. 336. Oct. 3rd, 1888.

[d] Ut. supra.

[e] Ut. supra.

marked example; therefore its application, save in rare cases, is unadvisable.

A somewhat similar process appears to have been known to the early Greek physicians, and is thus referred to in the Greek Anthology:—"Touching them with his hands he (the physician) quickly makes them whole."

A somewhat similar process was used from the earliest ages for depriving persons of consciousness. Merlin,[a] the magician, is credited by tradition with thus rendering insensible the "Knight of the Fountain."

Pepys,[b] in his letter to Lord Reay, makes mention of some of the superstitious practices to which the attempt to produce unconsciousness had degenerated in his time.

From the eleventh to the seventeenth centuries anæsthesia was produced principally by internal medication and by external application of drugs, though inhalation was not unknown. Indeed, the curative effects of the inhalation of the volatile principle of drugs has been handed down by tradition from pre-historic times: Aphrodite, to assuage her grief for the death of Adonis, threw herself on a bed of lettuce.

Pliny[c] refers to the effect of the odour of medicinal plants, and particularly to the anæsthetic effect of mandragora. "It has the power of causing sleep in those who take it." The dose is half a wineglassful. "It is taken against serpents, and before cuttings and puncturings, lest they be felt. For these purposes it is sufficient for some persons to have sought sleep from the smell."

The ingredients of Helen's nepenthe are unknown—many therapeutists consider it contained mandragora, and others,[d] as James

[a] The Book of Merlin, Cap. XIX.

[b] Pepys to the Lord Reay, Nov. 21, 1699.

[c] Pliny, Lib. xxxv., cap. 94.

[d] Paris. Pharmacologia. Eighth Edition. 1833.

Ayrton Paris believe the drug was opium. Its story, as told in the Odyssey, is:—"Immediately she (Helen) dropped into the wine, of which they drank, a drug—an antidote to grief and rage, inducing oblivion to all ills; he who drinks of this mingled cup sheds not a tear the live-long day, were death to seize his venerated sire, or her who gave him birth, or were the bloody sword buried in the bosom of his brother, or greatly-loved sister, no tear would even then bedew his cheeks."

Dioscorides ascribed narcotic properties to the smell of mandragora apples, and gives directions for making a decoction in wine of the root, thus—"And some making decoctions in wine of the roots to a third, this being strained is put past. Using one wineglassful in the case of the sleepless and those suffering excessive pain, and in the case of those on whom they wish to produce anæsthesia when cut or burnt."[a] This shows clearly that the drug was known to possess anæsthetic properties, and occupied a place in the therapeutics of the day.

Dioscorides fully recognised the difference between its hypnotic and its anæsthetic effects. Of the former we are told by him, in the same section, "Eating which (mandragora roots) shepherds are made sleepy." Of the latter, he says:—"Three wineglassfuls of it (a fluid preparation resembling the wine, in being prepared from the roots) are given to those who are about to be cut or burnt, as mentioned before, for they do not feel the pain through being lethargically affected," and again he says, "Physicians use this (and other preparations of it), too, when they are about to cut or burn."

Indeed, the soporific and anæsthetic effects of mandragora were known both to lay and medical writers, and their references to its action place its anæsthetic properties beyond doubt.

[a] De Med. Mat. B. IV., s. 76.

Thus Lucian, speaking of the "Isle of Dreams," says—"In a circle around it stands a wood, and the trees in it are tall poppies and mandrakes, and on them a considerable number of bats."[a]

In his "Demosthenis Encomium," 36:—"But he (Demosthenes) rouses his fellow-citizens unwilling, as if put to sleep by mandragora, employing his outspokenness as a sort of cutting and cautery of their apathy."

In his "Adversus Indoctum," 23:—"But do you think he has been so dosed with mandragora as to hear those things, and not to know?"

In his "Timon," 2. we find the phrase, "You sleep as if through mandragora."

Galen[b] makes a short reference to its power to paralyse sensation and motion.

The schools both of the Eastern and Western Califates were familiar with mandragora, and made use of its anæsthetic properties. Avicenna lays down special directions for its use, both as a hypnotic and anæsthetic, and for the treatment of those who have taken an overdose of the drug, laying stress on the necessity of keeping them awake. Averrhoes says of its apples that they are soporific. The later writers—Paulus and Aëtius, according to Dr. Adams, "borrow almost word for word from Galen," on the therapeutics of the herb.

Aëtius, according to Dr. Silvester,[c] says:—"Those who drink an infusion of the root fall into a deep and long-continued sleep, or stupor; danger was present when the patient kept constantly drawing in the air, through his mouth, gasping for breath; and if help was not soon afforded he died convulsed."

[a] Lucian, Ver. Hist. 11, 33.

[b] Galen, Lib. VII., p. 207.

[c] Anæsthetics, being a paper read before the South London Medical Society. Reported in the Medical Gazette, Vol. VI.

Paulus Ægineta[a] gives the following extract from Dioscorides:—"Its apples are narcotic when smelled to, and also their juice; that if persisted in, they will deprive the person of his speech." He mentions mandrake as an ingredient in anodyne collyria, and pessaries, and says that in an enema it induces sleep. He also quotes Isodorus:—"A wine of the bark of the root is given to those about to undergo operation, that being asleep, they may feel no pain."

Serapion says it is administered as an anæsthetic prior to operation.

Celsus[b] recommends a pillow of mandragora apples for the production of sleep. "If, however, they continue vigilant, some procure sleep by giving them a decoction of poppies or henbane to drink; others place mandrake apples under the pillow."

In 1787 Dr. Willis, by ordering a pillow of hops for George III., revived this method of treatment.

The drug was sometimes thrown on the fire or mixed with some inflammable substance. Thus, Andrew Borde,[c] of Pevensey, in Sussex, after he had "travelled through and round about Christendom, and out of Christendom into some parts of Africa," having obtained his M.D. in Montpellier, and become Physician to Henry VIII. and the author of several works, recommended for toothache "a candell of waxe with henbane seeds, which must be lighted so that the perfume of the candell do enter into the tooth."[d]

[a] Paulus Ægineta, Syd. Soc. Ed. B. V. and VII.

[b] Celsus. De Medicinâ. Lib. III., Cap. XVIII.

[c] A reprint (black letter) of Andrew Borde's travels was published in 1814, but no reprint, as far as I can learn, has yet appeared of his medical works. It is to be hoped that the Early English Text Society will undertake the task. Borde was a man of much travel, great reading, and a keen observer of men and customs, and his works would form a fitting supplement to the reprints of Bullein and Vicary, that this admirable Society has recently published.

[d] A Breviarie of Health, wherein are remedies for all manner of sicknesses and diseases, &c. By Andrew Borde, M.D. London. 1547. 4to.

When, however, the Moslems had introduced into Europe the discovery of the process of distillation, a new epoch commenced both in chemistry and surgery, and the inhalation of the vapours of the still, simple or mixed with narcotic herbs, quickly came into use.

An interesting account of one of the earliest of these anæsthetics is given by Sir Thomas Watson,[a] who copies the Italian of Ugone's Chirurgicus, of which the following is a translation :—"Among the Tuscan writers of some repute in surgery, Ugone da Lucca, born a little after the middle of the twelfth century, of the noble family of Borgognoni, appears to me of first rank. This Ugone was chief of the school of surgeons that treated wounds with wine, oakum, and ligature, with happy success. He had also some practice in chemistry. From him is derived the process of the sublimation of arsenic, described by Teodorico, his son. The latter describes also to us a certain oil *de lateribus*, chemically prepared by his father, and a most powerful caustic of his, and a soporific which by means of smelling alone put patients to sleep, on occasion of painful operations which they were to suffer."

That about this time anæsthetics were commonly known and largely employed in surgery, is a fair inference from the fact of their being soon afterwards so repeatedly referred to by poets and prose authors.

Guillaume de Sallaste Du Bartas, whose work is a dull Encyclopædia of his knowledge, writes in 1544 (silver-tongued Silvester's translation)—

> "Even as a surgeon, minding off to cut
> Some cureless limb, before in use he put
> His violent engines on the vicious member,
> Bringeth his patient in a senseless slumber,
> And griefless then (guided by use and art)
> To save the whole cuts off the infected part."—
> *La Première Semaine, ou la Création.*

[a] Sir Thomas Watson's Practice of Medicine. Fifth Edition. 1871. Vol. I., p. 131.

It is a curious commentary on the work that Sieur G. de S. Bartas died of unskilful surgery four months after the battle of Ivry, where he fought in the ranks of Henry of Navarre. His poem—which was founded on Tasso's—went through thirty editions in less than six years, and is said to have suggested "Paradise Lost" to Milton. The passage in his poem is paralleled by Middleton's[a]:—

> Hip.—"I'll imitate the pities of old surgeons
> To this lost limb, who, ere they show their art,
> Cast one asleep, then cut the diseased part."—
> *Women, beware Women*, Act 4, scene i.

Earlier than either of these poets is the notice by Boccaccio,[b] who in the story of Dioneus, gives the account of the effects of the anæsthetic mixture of Surgeon Mazzeo della Montagna, of Salerno, on Ruggieri da Jeroli:—

"The doctor had a patient who had a bad leg; this, he told the patient's friends, was owing to a decayed bone, which he was obliged to take out to make a cure, otherwise he must either lose his leg or his life; but yet he looked upon it as a very doubtful case. They, therefore, bid him do as he thought proper.

"Now the doctor, supposing that the patient would never be able to endure the pain without a soporific, deferred the operation until the evening; and, in the meantime, ordered a water to be distilled from a certain composition, which, being drunk, would throw a person asleep as long as he judged it necessary in this particular case."

[a] Published 1657. Thomas Middleton was born in London about 1570, and died on the 4th of July, 1627.

[b] Decamerone, 1352.

CHAPTER II.

Historical Notice continued—Bullein—Mandragora in Shakespere—Marlow—Jacques Yoer of Poiteau—Thligart Badē—In the Scriptures—Cannabis Indica—In the Koukin-i-ting—Heredotus—Vegetable Compounds as Anæsthetics—Guillame Bouchet—Cardow—Porta—The Sponge of Ugone da Lucca—Chumappe—Paré—Boerhaave—Anæsthetic Ointments—Case from Camerarius—Modern Anæsthetics—Pearson—Woolcombe—Faraday—Djafar Yeber—Morris—The Influence of Priestly's Discovery—Oxygen—Nitrous Oxide in Dentistry and Surgery—Davy—Wells—The First Case of Nitrous Oxide Anæsthesia — Biglow — Cotton — Evans — Mediæval Anæsthetics — Albertus Magnus—"Nepta"—Soap—Plants—Arthur Brooke—Shakespere—Case of the Elector Augustus—Morphine.

Of English anæsthetists the most celebrated is William Bullein, born in the Isle of Ely, in the beginning of the reign of Henry VIII. After a sojourn in London, Bullein settled in Durham, where he incurred the displeasure of Sir Thomas Hilton, who hired assassins to kill him; escaping this danger, he afterwards fell into poverty, was thrown into prison, and whilst there wrote many books. Amongst others, "Bullein's Bulwark of Defence against all Sickness, Soreness, and Wounds that dooe daily assault Mankinde: London—Printed by John Kingston, 1562, folio."[a]

The principal ingredient in Bullein's anæsthetic is supposed to have been the juice of mandragora. He thus describes its preparation:—"The juice of a certaine herb, pressed forth, and kept

[a] Bullein's works were published by Stickley in 1722. He died in 1576, and was buried in St. Giles, Cripplegate. A reprint of "A Dialogue against the Fever Pestilence" by William Bullein, from the edition of 1578, collated with the earlier editions of 1564 and 1573, edited by Mark W. Bullen and A. H. Bullen, was published by the Early English Text Society. The deficient means of intercommunication amongst members of the medical profession in the sixteenth century is well shown by the fact that Vicary does not appear to have known of Bullen's anæsthetic.

in a close earthern vesssel, according to art, bringeth deep sleep, and casteth man into a trance, or deep terrible sleep, until he shall be cut of the stone."

Shakespeare four times refers to the plant under the name of mandrake, and twice under the name of mandragora, and he is familiar with its soporific effects :—

> CLEOPATRA—"Give me to drink mandragora,
> . . . .
> That I might sleep out this great gap of time.
> My Antony is away."—
> *Antony and Cleopatra*, Act 1, scene v.

> IAGO— "Not poppy nor mandragora,
> Nor all the drowsy syrups of the world,
> Shall ever medicine thee to that sweet sleep
> Which thou ow'dst yesterday."—
> *Othello, the Moor of Venice*, Act 3, scene iii.

Marlowe refers to the narcotic power of the plant—

> BARABAS—"I drank of poppy and cold mandrake juice,
> And being asleep, belike they thought me dead,
> And threw me o'er the walls."—
> *The Jew of Malta*, Act 5, scene i.

Mandragora is still occasionally referred to by poets—

> "Have the pigmies made you drunken
> Bathing in mandragora?"
> Mrs. BROWNING—*Dead Pan, ii.*

Jaques Yoer of Poitou, remarks, in his "Printemps"—"And if I am so delighted (pardon me if I cannot lie) that, like a patient sent to sleep with mandragora, for the purpose of cutting off a limb, I do not feel my disease."

According to Thligarat Badē, a Persian work, and other authorities cited by Castell, and to be found in Lee's Hebrew Lexicon, Mandragora, when taken inwardly, renders one insensible to the pain of even cutting off a limb.

The herb has been used as an anæsthetic to avoid the pains

of labour, and Dr. Silvester[a] suggests that it was with this object in view that Rachel begged the mandrake fom Reuben.

Cannabis indica, according to the manuscript laid before the French Academy of Medicine by M. Julien, appears to have been used as an anæsthetic at an even more remote period of history than mandragora.

This manuscript, which is called "Koukin-i-ting," contains the following passage—"Hou-tho gave to the patient a preparation of hemp (ma-yo), and at the end of some instants he became as insensible as if he had been drunk, or deprived of life," and further remarks that the patient "found himself recovered, without having felt the slightest pain during the operation."

From passages in Herodotus we gather that the Greeks were not unacquainted with the intoxicating and hypnotic effects of the plant. He refers to its employment by the Scythians and the Massagetæ in two passages, and his statement has been verified by O'Shaughnessy, of Limerick, whose researches into the properties of Indian drugs are of world-wide repute. Other drugs were also employed. Guillaume Bouchet's work, entitled "Les Sérées, published in 1544, is quoted by Simpson, from whom the following extracts are taken—"Others have written that if you take some marble from Grand Cairo, called by the antients memphitis, reduce it to powder, and apply it as a liniment with vinegar, and lubricate with it the part to be cut off or cauterised, the patient will not feel much pain or inconvenience." Cardow says that a person "anointed with opium, celandine, saffron, and the marrow and fat of a man, with oil of lizards, or if he drinks wine in which the seeds of Portulaca marina has been steeped for a weeke, that it will prevent him feeling any pain."

The ancients were acquainted with the advantages obtained by com-

[a] Medical Gazette, Vol. VI.

bining drugs. Joannes Baptista Porta, in his "Natural Magic," copies from Dioscorides the method of preparing a sleeping apple "with opium, mandragora, juice of the water hemlock, seeds of hyoscyamus, and to these musk is added to impart an agreeable odour, collected into a large mass as large as one can hold in his fist;" this he adds "when repeatedly smelt, softens down and binds the eyes in sleep." Subsequently he states that "it is possible to extract from several soporific plants a quintescence, which is to be shut up in well-covered leaden vessels, lest the drug should evaporate. When it is to be used, the lid is to be removed and the medicament held to the nostrils, when its vapour will be drawn in by the breath and attack the citadel of the senses, so that the patient will be sunk in the deepest sleep, not to be shook off without much labour. After sleep no headache remains, nor any suspicion of art. Such things are clear to a wise physician; to a wicked one obscure."[a]

And according to Teodorico, Ugone's son, Bishop of Bitonto, and afterwards of Cervia, the somniferous sponge of Ugone da Lucca was prepared as follows:—

"Take of opium, of the juice of the unripe mulberry, of hyoscyamus, of the juice of hemlock, of the leaves of the mandragora, of the juice of the wood ivy, of the juice of the forest mulberry, of the seeds of lettuce, of the seeds of the dock which has large round apples, and of the water-hemlock—each an ounce; mix all these in a brazen vessel, and then place in it a new sponge; let the whole boil, as long as the sun lasts on the dog-days, until the sponge consumes it all, and has it boiled away in it. . . . . As oft as there shall be need of it, place this sponge in hot water for an hour, and let it be applied to the nostrils of him who is to be operated on, until he has fallen asleep, and so let the surgery be per-

[a] Natural Magic, Lib. III., 1579.

formed. This being finished, in order to awaken him, apply another sponge, dipped in vinegar, frequently to the nose, or throw the juice of the root of fenugrek into the nostrils; shortly he awakens."

M. Chumappe (1534) refers to the use of these somniferous compounds being used in his day, and Ambroise Paré refers to them as having been "formerly used" by surgeons. Boerhaave used opium as an anæsthetic, both by inhalation of its vapour and also given as a powder.

In Marherr's Prælectiones[a] there is an account of the anæsthetic effect of the odour of opium, and also a good description of "*Anaisthesia.*"

In Baron Van Swieten's Commentaries upon the Aphorisms of Boerhaave, the prescription for his anæsthetic powder is given with Aphorism ccccIxix., and is as follows:—

Oil of cinnamon	...	...	Two drops.
Oil of Cloves ...	...	...	One drop.
Citron peel ...	...	...	Two grains.
Sugar ...	...	...	Two drachms.

Mix and add red coral, prepared, one drachm; pure opium, two grains; mix for two doses, one of which is to be taken one hour before the operation, and the other one quarter of an hour before it. if the patient has not slept.

The drugs were sometimes rubbed up with oils to form liniments, which were rubbed over the body.

Dr. Silvester, in the *Medical Times and Gazette*, Vol. XXXVI., p. 504, Nov. 14th, 1857, quotes from the "Living Library," by R. Camerarius, A.D. 1625, done into English by J. Mole, Ch. XIII.— "Shee," says the venerable author, "rubs over all her bodie with a certaine oyntment, which we saw thorow the chinks of the doore.

[a] Prælectiones in Hermanni Boerhaave Institutiones Medicas cum prefatione Crantzii: Philip Ambros Marherr. Lovanii: Typis Academicis, MDCCLXXVIII.

The operation of the soporiferous juyces, whereof this oyntment was compounded, made her fall to the ground, and brought her into a deep sleep. Upon this we open the doore, and some of us begin to strike her and knock her well-favouredly, but she was so soundly asleepe that to strike her bodie and a stone it was all one." To which he appends a translation from the works of an alchymist for preparing a hypnotic tincture :—"The aforesaid drugs," says he, "or as many of them as possible, being converted into an essence, this is to be shut up in leaden vessels, most accurately closed, lest the subtile aura should escape, for in that case the virtues of the medicine would vanish away. At the moment of using, the lid being opened, the vessel must be brought immediately under the nostrils of the sleeping person, and he will draw in by breathing the most subtile strength of the vapour, and thereby his senses will be locked up as it were in a citadel, so that he will be buried in a most profound sleep from which it will be impossible to awaken him."

This admixture of vegetable products with distilled liquors may explain the conium and ether preparation of Dr. Richard Pearson :[a]—"The vapour of vitriolic ether (whether pure or impregnated with cicuta) drawn into the lungs three or four times a day, has been found serviceable in cases of catarrh, phthisis, pulmonalis, hooping-cough, and croup. At each inhalation two or three teaspoonfuls of ether are used."[b]

This was evidently the guide to Dr. Woolcombe, of Plymouth,

[a] A Practical Synopsis of the Materia Alimentaria and Materia Medica. A new edition, comprising the latest Improvements in the London, Edinburgh, and Dublin Pharmacopœias. By Richard Pearson, M.D. London. 1808.

[b] In 1758 Dr. Michael Morris protested against vegetable products being added to the still during the distillation of ether (see Medical Observations and Enquiries, by a Society of Physicians in London, Vol. II.). London : Printed for William Johnson, in Ludgate-street, MDCCLXIV.

whose case is thus told by Sir Thomas Watson :[a]—"A former patient of mine told me this history of herself—She had been sorely tried, in her earlier years, with paroxysms of urgent dyspnœa, frequently recurring, and her life was thought to be in danger. After fruitless trials of various other remedies, the following method was adopted, with the happiest result (under the advice of a physician of high promise, who died young, the late Dr. Woolcombe, of Plymouth) :—About two teaspoonfuls of sulphuric ether were poured into a saucer, which was placed on her lap, and over which she breathed, as she sat gasping in bed, with a shawl thrown over her head to prevent the escape of the vapour. Very soon a delightful sensation of tranquillity ensued; 'she felt' (I quote her own words) 'as if going to heaven in the heavenly way,' and presently she sank back unconscious. As soon as this happened, her husband (the late distinguished Admiral of the Fleet, Sir T. Byam Martin), by whom the process was managed, withdrew the shawl, and in a short time Lady Martin recovered, breathing calmly. This mode of quieting attacks of asthma was begun in 1806. . . . Lady Martin survived the prediction of her early death for forty-four years."

To Faraday, however, may be credited the recognition of the value of ether as a surgical remedy; in 1818 he showed that the vapour of sulphuric ether, when inhaled, produced anæsthetic effects similar to those produced by nitrous oxide gas.

Its discovery is believed to be due to the Arabian chemist, Djafar Yeber, and the method of its manufacture to Dr. Michael Morris, who both explained its method of preparation and advocated its use as a medicinal agent both internally and as an external application.

[a] Lectures on the Principles and Practice of Physic, delivered at King's College, London. By Sir Thomas Watson, Bart., M.D., F.R.S. Fifth Edition. London: Longmans, Green, & Co. 1871.

In his letter, read before a Society of Physicians in London, on the 18th of December, 1758, may be found the first hint of its use by inhalation.[a]

Immediately after Priestley's brilliant discovery of oxygen in 1774, the profession sought in the newly-discovered gas, which came to be designated "vital air," a panacea; its exhilarating effects were manifest, and in cases of cardiac asthenia its benefits were marked; amongst the first to utilise the remedy were Dublin physicians, and on the 7th of July, 1817, Dr. R. Read[b] read a paper before the Association of the Fellows and Licentiates of the King and Queen's College of Physicians in Ireland, "On the Use of Oxigen Gas in Angina Pectoris."

"The following is the case of a gentleman, aged sixty-six, . . . he suffers from violent pain across the chest, extending from thence down the arms, sometimes even as far as the fingers. . . . .

"From the circumstances antecedent, and during the paroxysms, I was now led to propose to Dr. Harvey and Mr. Macklin, that our patient should inhale a quantity of oxigen gas immediately on the threatening or approach of the attack.

"On the 5th of July in the evening . . . I made him inhale a quart of the gas."

The transition from the use of oxygen gas to nitrous oxide was slight, and in 1799 Mr. Davy (afterwards Sir Humphrey), then of Bristol, relieved the pain caused by a wisdom tooth cutting the gum with the inhalation of nitrous oxide gas. And the following

[a] Med. Obs. and Enq. By a Society of Physicians in London. Vol. II., p. 176, MDCCLXIV. In this volume may also be found Mr. Lambert's paper on the value of acupressure in arresting arterial bleeding, read by William Hunter.

[b] Transactions of the Association of Fellows and Licentiates of the King's and Queen's College of Physicians in Ireland. Vol. i. Dublin: Printed at the Hibernia Press Office, for John Cuming, 16, Lower Ormond-quay; and Longman, Hurst, Rees, Orme, and Browne, London. 1817.

year he published the following statement:—"As nitrous oxide in its extensive operation seems capable of destroying physical pain, it may probably be used with advantage in surgical operations in which no great effusion of blood takes place." The anæsthetic, however, remained unnoticed until Mr. Horace Wells, of Hartford, Connecticut, tried its effects in extraction of teeth, and, after some consecutive failures, discontinued its use.

Four years afterwards Mr. Bigelow "ablated" the breast of a patient who was under its influence.[a]

Quite recently, however, on the 9th of October, 1888, at a meeting of the New York State Medical Association, Dr. Oliver P. Hubbard,[b] of New York County, stated that midway in time between Davy's suggestion as to the surgical use of nitrous oxide and its application by Wells, an event occurred which, had it been rightly interpreted, might have greatly hastened all the good results induced by anæsthesia.

"I now propose," he states, "to report to the Association a very early case of anæsthesia by nitrous oxide, with supporting testimony.

"About sixty-seven years ago Dr. Stockman, a German druggist of Utica, came to Rome, Oneida county, to exhibit the well known effects of its inhalation to a large number of people, on the evenings of November 5, 6, and 7, 1821, in the hotel and county court-house. On the first evening occurred an incident still fresh in my memory, which I have frequently cited to my classes. I have sought in vain to discover a record of a case of an earlier date. I have always intended to publish this case, and during these years to fortify my own impressions, I have procured from living witnesses written confirmation of all my recollections.

[b] Boston Medical Journal. Vol. I., p. 17.

[a] A Case of Anæsthesia by the Inhalation of Nitrous Oxide, supposed to be the First on Record. Read at a meeting of the New York State Medical Association.

"My elder brother, William G. Hubbard, then sixteen years old, was present at Dr. Stockman's exhibition, and was one of those who took the gas. On the 14th of October, 1852, I wrote to him at Elgin, Ill., sending a copy of entries made at the time in my school journal, and adding, in substance, "Now I will relate from memory. On the first evening, when the exhibition was closed (the doctor saying there was no more gas), and while many were standing around the fire talking over the occurrences, the doctor went into the dressingroom on the north, and found a young man lying on the floor close by the gasometer, entirely senseless.

"'He had gone in stealthily, turned the stop-cock, and taken his fill, and here was the legitimate result—a case of complete anæsthesia, probably the first by this means ever authenticated.

"'The alarm was great. Death seemed imminent, if not present. He was lifted with difficulty by two persons, one under each arm, and brought into the large ball-room; and, after long and anxious suspense, he came to his natural state unharmed. How long he had been under the influence of the gas could not be known, for "the sweet was stolen." Can you recall this singular this singular incident and those connected with it?'

"On the 22nd he replies:—

"'I well remeber old Dr. Stockman's performances at Rome. Your recollections, as far as you express them, agree almost exactly with my own. I do not know the name of the person; but that, I suppose is not material. He was found as you mention, lying insensible with his mouth applied to the faucet. No means were applied to restore him to consciousness. He was brought out into the ball-room, and a crowd immediately gathered around, watching the case.

"'After a few minutes his feet began to move slightly, with a gradually increasing motion to a very rapid one, evidently making

an effort to dance. He was thus held up by the arms, with his feet flying like drumsticks, and gradually recovering the use of his limbs until he could dance alone.

"'He danced in this way until the effect of the gas had subsided, and then appeared entirely exhausted. No injurious or unpleasant effect was noticed, and after resting a while he appeared as usual.'

"In November, 1883, I addressed a similar letter to an early friend and schoolmate, Mr. William E. Wright, all his life a resident of Rome, to which he replied as follows:—

"'In answer to your inquiries, I would say that I remember the incidents as to the lecture of Dr. Stockman at the hotel ball-room, not from personal presence, but from my father, who was there, of an attack made upon him by Ephraim Smith when under the influence of the gas, who chased him from the ball-room into and through adjoining rooms until he came to himself again. I also remember the case of the person who became overcharged at the gasometer. I remember the lecture at the court-house from personal presence, and witnessed the agility of one man (M'Donnell), who, under the influence of the gas, immediately started on a run upon the top rails of the right hand tier of rising slips up through the people therein, causing great excitement and fear by the people, who seized and held him by force until he came out of the gas influence. Finding himself so held he was extremely mortified at his act and condition.'

"In August, 1887, wishing to confirm as far as possible the above recitals, I obtained from my cousin, Rev. Charles P. Grosvenor (Yale, 1827), of Pomfret, Conn., his recollections of these events, which occurred when, a boy of sixteen, was at school in Rome. They coincide with the preceding; and he adds, 'When thus held up and reviving, the young man would throw his feet as high as his head.'"

The success of the remedy in dentistry is fairly due to the untiring energy of Dr. G. Q. Cotton, an American dentist, who, in 1867, proceeded to Paris, and, supported by the opinions of Evans and Préterre, succeeded in getting it a trial at the hands of the Parisian dentists.

It was Cotton's apparatus with which Dr. Evans gave his demonstrations at the Dental Hospital (March 31st, 1868), and, in consequence, led the Odontological Society of Great Britain to consider the subject.[a]

To whom we are indebted for the commercial application of the liquefaction of nitrous oxide is difficult to determine; at any rate, it is known that Dr. Evans brought nitrous oxide in a liquid state into England.

To the general surgeon nitrous oxide has not commended itself, and the majority of surgeons who perform operations use either chloroform or ether.

Of many of the anæsthetics used during the Middle Ages, the formulæ have not been handed down. Albertus Magnus makes mention of an animal product of which he says: "Any person smelling it falls down as if dead and are insensible to pain," and similar effects are by him ascribed to the "bieith," or "nepta," a vegetable product.[b] "In 'Le Procès Criminel,' by Claude Lebrun de la Rochette, we have the following remark as to the employment of such drugs by criminals about to suffer torture—'As to their artifices not to feel the pain of the rack, I saw in the first year of my reception at the bar of Beaujolais, which was in the year 1588, that one of the four thieves, who were prisoners—the chief named Grand François—a man of gigantic stature, was put to the rack,

[a] A Manual of Nitrous Oxide Anæsthesia. By J. Fredk. W. Silk, M.D. (Lond.), &c. London: J. and A. Churchill. 1888.

[b] De Mirabilis Mundis.

fell asleep, and the toes were torn from both his feet, without his manifesting any signs of pain. One of his companions observed that he had eaten soap, which stupified the nerves. The remedy to the artifice is to give wine, which being brought and drunk, he then said he was dead, and without any further torture freely confessed an infinite number of murders and robberies, to atone for which he and his companions were broken in the wheel by sentence of Master Thomassot Provost, of the Mareschals in Beaujolais.' "[a]

Arthur Brooke[b] (1562), in his "Tragicael Historye of Romeus and Julietta, containing a rare example of love constancie, with the subtiel counsels and practices of an old Fryer, and their illevent," makes mention of the use of an anæsthetic in the following passages:—"This frier Laurence . . . . was an auncient Doctor of Divinity, of the order of the friers Minors who was very skilful in Philosophy, and a great searcher of nature secrets, and exceeding famous in Magike Knowledge, and other hidden and secret sciences," to Julietta in her distress he says: "I have learned and proved of long time the composition of a certaine paaste, which I make of divers soporiferous simples, which beaten afterwards to powdre, and dronke with a quantite of water, within a quarter of an houre after, bringeth the receiver into such a sleepe and burieth so deeply the senses and other spirits of life, that the cunningest Phistian wil judge the party dead: and besides that it hath a more marvellous effect, for the person which useth the same feeleth no kinde of grief, and according to the quantitie of the dough, the pacient remaineth in a sweet slepe, but when the operation is perfect and done, hee returneth into his first estate."

[a] Simpson's History of Anæsthetics.

[b] Shakespere's "Romeo and Juliet" was published in 1597, and Arthur Brooke's Historye supplied him with much material.

The Shakesperian references to the anæsthetic properties of plants are familiar to almost all professional men :—

FRIAR LAURENCE—"Within the infant rind of this small flower
Poison hath residence and medicine power ;
For this, being sweet, with that bait cheers each part,
Being tasted, slays all senses with the heart."—

Romeo and Juliet, Act 2, scene iii.

And a little further on he says—

"Take thou this phial, being then in bed,
And this distilled liquor drink thou off ;
When presently through all thy veins shall run
A cold and drowsy humour ; for no pulse
Shall keep his native progress, but surcease.
No warmth, no breath, shall testify thou livest ;
The roses in thy lips and cheeks shall fade
To paly ashen; thy eye windows fall,
Like Death, when he shuts up the day of life;
Each part, deprived of supple government,
Shall stiff, and stark, and cold, appear like death;
And in the borrow'd likeness of shrunk death
Thou shalt continue two-and-forty hours,
And then awake as from a pleasant sleep."

Romeo and Juliet, Act 4, scene iii.

In *Cymbeline*, the following lines occur—

"Those she has
Will stupify and dull the sense awhile,
Which first, perchance, she'll prove on cats and dogs;
Then afterwards up higher ; but there is
No danger in what show of death it makes
More than the locking up the spirits a time
To be more fresh, reviving."—

Cymbeline, Act 1, scene vi.

The fact that the older surgeons were able to fix the length of time which the anæsthesia was to last is of much interest, and their power is well shown in the length of time, forty-two hours, fixed by Friar Laurence for the anæsthetic effect of the draught to continue on Juliet. Modern anæsthetic has not attained to such power and precision.

One of the last cases in which anæsthesia was produced by the internal administration of a drug is the remarkable one in which the pupil of Jean Louis Petit Weiss operated on Augustus Elector of Saxony and King of Poland, at a time when Saxony was one of the leading States of Germany, and Poland was the champion of Europe against the Turk.[a]

The foot was amputated successfully under the anæsthetic, and Augustus declared the operation was painless. It is quite possible—indeed it is probable—that the draught was prepared by one of the Sclave population of Poland; for although Petit's reputation occasioned his being summoned to attend not only the French monarch but also the kings of Spain and Poland, yet there is no mention of his having on any other occasion anæsthetised a patient prior to operation, although almost every detail of his life is known to us: how he first commenced the study of anatomy, at seven years of age, became, at twelve, superintendent of Littré's anatomy room, and finally attained a European reputation.

Perhaps the last occasion in which an internal remedy was used to produce anæsthesia was that recorded by Dr. Chisholm,[b] of Inverness, who substituted the internal use of morphine for ether inhalation in a case of ablation of the breast, successfully performed on a woman, who declared she felt no pain during the operation.

[a] Skizzen, or Sketches by A. G. Meissner, published at Carlsruhe in 1872, and translated by Dr. Silvester.

[b] Lancet. Vol. I., p. 578. 1847.

CHAPTER III.

Discovery of Chloroform — Silliman — Claims to Priority — Guthrie — Liebeg Soubeiran—Flourens—Jacob Bell—Introduction into Surgery as an Anæsthetic—Claims to Priority—Ives—Simpson—Waldie—Simpson on Chloroform —Universal Adoption—Reckless Administration—Modes of Administration— Simpson's—McGuire's—Skinner's.

The empiricism that guided our forefathers in the practice of surgery is nowhere better shown than in their use of anæsthetics; although they knew of their power to prevent pain during cutting and burning operations, they never seem to have used them for the prevention of the pain caused by returning dislocated limbs to their normal position, or for the setting of a fractured one. Any reader of Galen's seventh book will know how painful many of the methods adopted for reducing luxations were; and in the illustrated editions of his works the artist graphically depicts the look of agony on the faces of the unfortunate patients who are undergoing the torture of the cumbrous methods adopted to produce reduction of luxations during the Middle Ages.

The older surgeons appear not to have recognised the fact that anæsthetics relax the muscular tissue; so we find that when the relaxation of the muscular tissue was determined on, the lancet or a warm bath was resorted to, and the surgeon's pupil was always instructed to take advantage of the patient having fainted to attempt the reduction.

Certainly the fact that the patient was formerly kept for hours under the influence of the anæsthetic may have had something to do with their not using these agents in the case of luxations, for they may have dreaded lest any indiscreet movement on the part

of the patient whilst recovering from the effects of the drug would re-produce the injury.

The discovery of Mr. Davy, of Bristol, in 1799, of the anæsthetic effects of nitrous oxide gas marks an epoch in modern surgery, and with the beginning of the nineteenth century commenced the scientific investigation of anæsthetic agents. Most fortunately for medicine, the examination of the proposed agents, as a rule, fell to the lot of the most gifted scientists. Davy examined nitrous oxide gas, and Faraday first enunciated plainly the anæsthetic properties of ether.

The century was still young when a correspondent of the *American Journal of Science and Art*, edited by Mr. Silliman, drew attention to the fact that a mixture of alcohol and the newly-discovered chloride of olefiant gas was an agreeable and diffusible stimulant. This notice attracted the attention of a reader of and writer for the journal, Mr. Samuel Guthrie, of Brimfield, Mass., who was then residing in Sackett's Harbour, New York State. His article was entitled, "A Spirituous Solution of Chloric Ether," describing its preparation and properties, and reached Mr. Silliman, the publisher of the journal, on the 8th of May, 1831, having been completed by the author some months previously, and it appeared in Oct., 1831. A later and fuller account, referred to by Dr. Jonathan Pereira,[a] was published by Mr. Guthrie[b] in January, 1832, as follows:—"Into a clean copper still put three pounds of the chloride of lime and two gallons of well-flavoured alcohol, of sp. gr. 0·844, and distil. Watch the process, and when the product ceases to come over highly sweet and aromatic, remove and cork it up closely in glass vessels. The remainder of the spirit should be distilled off for a

[a] Pharmaceutical Journal. Vol. V., p. 412. 1845–46.

[b] Silliman's American Journal of Science and Art. Vol. XXI., p. 64.

new operation. The proportions are not essential; if more chloride of lime be used, the ethereal product will be increased; nor is it necessary that the proof of the spirit should be very high; but I have commonly used the above proportions and proof, and have every reason to be satisfied with them. From the above quantity I have usually obtained about one gallon of ethereal spirit."

Guthrie's claims did not pass unchallenged, although Dr. Pereira had declared in his favour, and for a considerable time Soubeiran was credited with the discovery. His paper appeared in January, 1832.[a] In 1831 he submitted to distillation a mixture of chloride of lime and alcohol, and examined the distilled product. He found it to consist of carbon, 14·39; hydrogen, 2·35; chlorine, 83·26.

The atomic composition which he gave for this liquid was CHCl. He termed the liquid *bichloric ether*, because it contains, as he says, twice as much chlorine as is contained in the chloride of olefiant gas.[b]

Latterly Liebig, even in some of our best books, is awarded the honour of being the discoverer of the chemical.

His account was published in November, 1831, six months after Guthrie's MS. was in the publisher's hands, and one month after its publication. Dr. Pereira gives the date of publication in the *Ann. de Chem. et de Phys.*, XLIX., as 1832, and writes of Liebig as follows:—"In 1832 he examined the product obtained by submitting to distillation, in a capacious retort, diluted alcohol and chloride of lime. He analysed the distilled product, but failed to detect the hydrogen in it. According to his experiments, the compound consisted of carbon, 12·6523; chlorine, 88·18. The formula which he deducted from this analysis was C_4Cl_5, and he called the liquid *chloride of carbon*."

[a] Ann. de Chem. et de Physique. Tom. XLVIII., p. 131.

[b] Dr. Pereira. Pharm. Jour., Vol. V., p. 412.

Thus we find that three chemists were unwittingly all approaching a great discovery; and although Guthrie antedated the others by a few months only, nevertheless he is entitled to the credit of the discovery, and his American brethren have at last become alive to their duty towards him, and a monument is to be erected to his memory by the Jefferson County (N.Y.) Historical Society.

It is a curious fact that Guthrie, who was born in 1782, and was a surgeon in the U. S. A. in 1812, just lived to hear the chorus of applause that greeted Simpson's introduction of chloroform anæsthesia, and to see the claims of Professor Ives, of Yale College, ignored. He died in 1848; and until the Chicago Medical Association undertook to investigate his claims, he was literally unknown to the profession—and the ordinary biographical dictionaries, which delight to perpetuate the memories of nobodies, have no space for Samuel Guthrie.

The three independent discoverers selected each a different name for the chemical, and when, in 1834, Dumas[a] examined the liquid, he showed that Soubeiran had not obtained "it pure, and that Liebig made an error with regard to its composition. From his analysis of the pure liquid, he deducted the following as its real formula:—C_2HCl_3. On account of the relation of its composition to that of formic acid (C_2HO_3.), Dumas denominated this liquid *chloroform*."

Liebig admitted the accuracy of Dumas' analysis by adopting his formula of the composition of this liquid. He, however, disregarded Dumas' name for the substance, and adopted that of the chloride or terchloride of formyle (formyle chloride).[b]

In a letter to Dr. Jacob Bigelow, of Boston, dated from Edinburgh, April, 1870, by Sir James Young Simpson, he states that

[a] Ann. de Chem. et de Phys., LVI., p. 134.

[b] Dr. Pereira, *ub. supra.*

"the first case of an anæsthetic operation under chloroform occurred at Edinburgh on the 15th of November, 1847," and he appears to have been induced to try it on his patient because of the unpleasant smell the vapour of ether gave his clothes, which was extremely unpleasant to some of his patients. He writes:—"I found that no busy obstetric practitioner could extensively employ sulphuric ether without inevitably carrying about with him, and upon his clothes, an odour so disagreeable to many other patients and other houses, as to make his presence there aught but desirable."[a]

What led Simpson to select chloroform as an anæsthetic is thus told in Mr. Waldie's "Medicinal History of Chloroform:"[b]—"To the best of my knowledge, from the result of many inquiries, it (chloric ether) seems to have been introduced into this country as a medicinal agent first in Liverpool, where, indeed, in the form of a spirituous solution, it has been more known than in any other part of the country, and from which, I believe, the knowledge of its therapeutic properties has extended. About the year 1838 or 1839, a prescription was brought to the Apothecaries' Hall, Colquitt-street, one ingredient of which was chloric ether. No substance being known here of that name, having the properties of that with which the mixture was previously prepared, Dr. Brett, then the Company's chemist, in investigating the subject, found, in the United States Dispensatory, the formula for its preparation, and prepared some. Its properties pleased some of the medical men, particularly Dr. Formby, by whom it was introduced into practice in this town (Liverpool).

"After coming to take charge of the Company's laboratories, I found that the method of preparation yielded a product which was not of uniform strength, and sometimes of disagreeable flavour.

[a] Simpson's History of Anæsthesia.

[b] Lancet. Vol. II., p. 687. 1847.

Accordingly, I altered the process by separating and purifying the chloroform, and dissolving it in pure spirit, by which a product of uniform strength and sweet flavour was always obtained. Thus prepared, it is much superior to specimens I have seen of London manufacture. Those members of the profession who are in the habit of using it, prefer it greatly to sulphuric ether, as possessing all its remedial value, and being very much more agreeable. The vapour of the so-called chloric ether seems to have been tried as a substitute for sulphuric ether in February or March last, but without very satisfactory results, which, indeed, could scarcely be expected, unless the vapour of alcohol possessed the same properties, it being composed principally of alcohol. When in Scotland, in October last, Dr. Simpson introduced the subject to me, inquiring if I knew anything likely to answer. Chloric ether was mentioned during the conversation, and being well acquainted with its composition, and with the volatility, agreeable flavour, and medicinal qualities of chloroform, I recommended him to try *it*, promising to prepare some after my return to Liverpool, and send it to him. Other engagements and various impediments prevented me from doing this so soon as I should have wished, and in the meantime Dr. Simpson, having procured some in Edinburgh, obtained the results which he communicated to the Medico-Chirurgical Society of Edinburgh on the 10th of November."

The Edinburgh *Daily Review* of October 27th, 1869, contained an account of a banquet given to Simpson in recognition of the material advantage to the city of his residing there, and he was complimented by the Lord Provost on his discovery, twenty-two years after his first use of chloroform as an anæsthetic, and thirty-seven years after it was first used by Professor Ives, of New Haven, whose case is related under date of 2nd January, 1832.[a]

[a] Silliman's Journal. Vol. XXI., January, 1832.

Notwithstanding the many opportunities afforded to Simpson of acknowledging the claims of Americans to the discovery of the anæsthetic properties of chloroform, there is no mention on his part of their priority of claim to the discovery, and Guthrie and Ives remained unknown to the multitudes that gave the credit to Simpson.

Chloroform rapidly grew in public favour, and in a short time might be said to be the sole anæsthetic employed. In 1847, Simpson published a pamphlet, which was virtually a reprint of the paper he read before the Edinburgh Medico-Chirurgical Society, and as it gives a good picture of the professional opinion of chloroform when it came into general use, I give some extracts from it:—"Chloroform," says Simpson, "was first discovered by Soubeiran (1831) and Liebig (1832). . . . . It has been used by some practitioners internally. Guillot prescribed it as an antispasmodic in asthma, exhibiting it in small doses, and diluted one hundred times. But no person, so far as I am aware, has used it by inhalation, or discovered its remarkable anæsthetic properties till the date of my own experiments. . . . . As an inhaled anæsthetic agent, it possesses over sulphuric ether the following advantages." These advantages may be summarised as follows:—

1. A much less quantity of chloroform than of ether is requisite to produce the anæsthetic effect.
2. Its action is more rapid and complete, and generally more persistent.
3. Patients prefer it to ether.
4. It is less expensive than ether.
5. Its perfume is agreeable, that of ether being the reverse.
6. It is more portable and easily transmissible than ether.
7. No special kind of inhaler or instrument is necessary for its exhibition.

Simpson's original paper had some clinical reports on the effects of the new anæsthetic, which are wonderful examples of word-painting, notably the first case, that of an infant, which is as follows :—

"A child of ten weeks old had a very large nævus behind the ear. Dr. Duncan destroyed its internal organisation by passing large red-hot needles in different directions through it. While the tumour was hissing and decomposing under their action, the infant lay quietly and placidly asleep on my knee under the influence of choroform."

On the publication of Simpson's paper, *L'Union Médicale*, Nov. 23, 1847, claimed that it is to France and to a French physician that all the honour of priority of discovery is due.

The claim was founded upon a communication made by M. Flourens, in March, 1847, to the French Academy of Sciences, and published in the 24th volume of the *Comptes Rendus*, which was as follows :—

"Hydrochloric ether produced the same effect as sulphuric ether. The action of hydrochloric ether has led me to test the properties of the new compound known under the name of chloroform. In a few minutes (from four to six) an animal exposed to the respiration of the vapour of this liquid became perfectly etherised. The spinal marrow was then laid bare, and the posterior roots were found insensible."

Mr. Jacob Bell had, however, priority to either Simpson or Flourens in the use of the anæsthetic, for in the *Pharmaceutical Journal* for February, 1847, he wrote that chloric ether as an anæsthetic "has been tried in some cases with success. It is more pleasant to the taste, but appears to be rather less powerful in its effects than sulphuric ether."

Chloroform was largely used for other purposes than as an

anæsthetic when it was first introduced. It was used internally as early as 1832 by Professor Ives and Dr. Nathan B. Ives in asthma, spasmodic cough, scarlet fever, and atonic quinsy. It was employed by Dr. Formby, of Liverpool, in hysteria, in 1838; by Dr. Tuson, of London, in cancer and neuralgic affections, in 1843; and by M. Guillot, of Paris, for asthma, in 1844. M. Chandler's case of spasmodic asthma was treated by the inhalation of the vapour of the drug, and, as published in the *Medical Gazette* for the 17th of December, 1847, has many points of resemblance to Professor Ives' case of January, 1832.

In a paper on the history of chloroform, read before the Medical Society of London on the 6th of December, 1847, by Dr. Cogswell, he makes the following statement: "I have reason to know that Dr. Pereira has been in the frequent habit of using chloroform medicinally, both in hospital and private practice, for several years past."

There is no claim put forward on behalf of Dr. Pereira for having given it by inhalation; but Pereira was a reader of *Silliman's Journal*, and from it transcribed for the *Pharmaceutical Journal*, Vol. V., Guthrie's method for preparing the substance. Consequently, we can hardly believe him to have been ignorant of the therapeutic value of its inhaled vapour.

The opinion formed of the substance as an anæsthetic by the leaders of medical opinion soon after its introduction in 1847 is worth recording. The *Medical Gazette* of the 3rd of December, 1847, writes:—"During the last week the chloroform has been employed as a means of allaying pain during surgical operations in most London hospitals. As far as we can learn, the result of this experiment, as tested in several capital operations, has been to show that this agent produces its effect with more rapidity and certainty than the vapour of ether, and that its action appears to

be attended with fewer disagreeable consequences—such as the evidences of pulmonary irritation, &c. Its influence as regards the condition of the patient during the operation is considered to be nearly identical with that of ether."

It was given in quantities that would shock the modern surgeon, and its administration was entrusted to any person. Not infrequently assistants in chemical laboratories amused themselves by putting each other under the influence of the new remedy. No precaution was taken in its administration; it was given on handkerchiefs or towels, and there was no regard paid to quantity. Some of the fluid was poured on a cloth, and this was held over the patient's face until anæsthesia was produced. Simpson recommended a towel folded into the shape of a cone—a method which is still used by many surgeons; indeed, Dr. Hunter M'Guire, in his pamphlet on anæsthetics, considers that a towel makes a better inhaler than any of those whose excellences are duly or unduly magnified by instrument makers. From my own experience, I prefer Skinner's apparatus; it allows of a free admixture of atmospheric air, and if the chloroform is added to it drop by drop from a York glass drop-bottle, I cannot believe an untoward result possible in a case selected with any ordinary amount of skill.

It cannot be a matter of surprise that the reckless administration of a potent medicine by persons ignorant, not only of the nature and physiological effects of the drug, but in many cases of the veriest rudiments of anatomy and physiology, should end in disaster, and that a very valuable agent should have been brought into disrepute.

One of the earliest to protest against the indiscriminate use of the remedy by ignorant persons, and the reckless manner in which it was used by the profession, was the late Mr. H. Stapleton, who, in a speech at a medical meeting in the winter of 1847,

foretold what would be the result of the then method of using the drug. Very soon "Death from Chloroform" became a familiar heading in medical papers; the public confidence was shaken, and coroners' inquests became inquisitorial courts, prying into the precautions taken to avert death. It was found that certain persons could not inhale chloroform vapour with impunity, and that an examination of the physical condition of the patient about to be anæsthetised was advisable, and, indeed, necessary; precautions were taken to remove all impediments to free respiration, and stays were undone, and waist belts unloosened—in fact, the profession, having burnt their fingers through carelessness, discovered that the public would not tolerate a recklessness in the discharge of their duties, and they commenced to adopt measures for public safety which should have been in use from the beginning; but when the public appeared satisfied with the steps taken, all at once professional energy slackened, and to this day, of the many licensing bodies that grant certificates in medicine and surgery, not one of them requires the student to be trained in the administration of anæsthetics, and no lectures on pharmacology are demanded, and in the majority of them the chemistry examination is a sham, so that a very small percentage of practitioners commence their career with anything like a proper knowledge of "substitution" products, and the "fatty" and "aromatic" series are to the majority unknown even in name. The natural result is that on a death occurring during anæsthesia the evidence that death results from fatty heart is usually conclusive. Neither the composition nor the physiological action of our principal anæsthetics being properly taught, and the student commences practice too often guided by empiric rules, when he should possess an intelligent conception of the nature, action, power, and uses of the drug, together with a clear idea of how best to counteract any injurious effects of it. Until this is

done, the true value of the drug will neither be known nor appreciated, and we shall go on ascribing deaths to other than their true cause—the neglect of our licensing bodies to enforce thorough training in an essential of the science of medicine.

CHAPTER IV.

Development of Modern Anæsthetics—The Work of Beddoes—His Idea on Inhalation—His Employment of Ether by Inhalation—Letter of Pearson—Faraday on Ether Inhalation—Indiscriminate Adoption of Medicated Inhalations—First Case of Ether Anæsthesia in Surgery—Long—Fatal Accidents from Nitrous Ether Vapour.

THE *renaissance* of science that marked the termination of the eighteenth century happily synchronised with the humoral pathology of the period, and in the chemical investigation of the tissues pathologists sought for the cause of all diseases. Amongst the most distinguished, both for originality and eccentricity in that age, was Thomas Beddoes, the son of a tanner in the village of Shiffnal, in Shropshire, where he was born in April, 1760. At the very commencement of his career the discoveries of Black and Priestley were exciting the admiration of scientists, and young Beddoes, who in 1776 had, through the kindness of his grandfather, entered at Pembroke College, Oxford, fully participated in the interest they excited.

In 1784 he translated the "Opuscules de Physique Animale et Vegetable" of the Abbé Spallanzani. He now definitely decided on medicine, and he went to Edinburgh, where he attended Cullen's lectures, and was selected by him to annotate his translation of Bergman's "Essays on Elective Affinity." After graduating as M.D. in 1786, Beddoes visited Lavoisier, and on his return from the Continent he was appointed Reader in Chemistry to the University of Oxford, but his sojourn in France had made him a convert to Republicanism, and the Oxford dons took fright, so Beddoes was dismissed the appointment, and a less brilliant chemist, but a more conservative politician, replaced him in 1792

Believing that Dr. Mayow, whose "Tractatus quinqæ Medico-Physico, Quorum primum agit De Sal-Nitro et Spiritu Nitros Aereo, Secundus De Respiratione, Tertius De Respiratione Fœtu-in utero et ovo, Quartus De Moto Musculari, Ultimus De Rachidite"[a] (1673), had fascinated him, was not fully credited with the discoveries made by him during the preceding century, Beddoes republished some of his works in 1790, under the title of "Chemical Experiments and Opinions."

On leaving Oxford he retired to Shropshire, where he commenced his investigations into the theory of the humoral pathology, which fascinated him so much that his whole after-life was devoted to the study. Pamphlet followed pamphlet, and his energy seemed inexhaustible; he wrote a moral story—the "History of Isaac Jenkins"—to try and check drunkenness, and his pamphlets ranged from the celebrated one, "Encouragement of Quackery by the Clergy," to the "Rights of Man." He held that all diseases were due to the excess or deficiency of some elementary constituent of the body, and his practice was in conformity with these views. He attributed scurvy to a deficiency of oxygen, and phthisis to an excess of that elementary body.

He now determined to put his theory to the test of practice, and he decided on establishing a pneumatic hospital, where patients were to be submitted to the inhalation of such gases as would, in his opinion, remedy the deficiency or excess of the elements which caused their illness. His first decision was in favour of London as a proper site for the institution, but finally he decided on Bristol, and on the establishment of his hospital in 1798 he commenced the publication of a journal entitled *Contributions to Medical and Physical Knowledge from the West of England.* His labours as

[a] A life of Mayow was published by Dr. Benjamin Ward Richardson in the Asclepiad. Vol. IV., p. 55. 1887.

editor, pamphleteer, and physician, so occupied his time that an assistant to superintend his laboratory became a necessity. At the suggestion of his friend, Mr. Gregory Watt, he engaged a young man, Mr. Humphrey Davy, as his assistant. In the following year Mr. Davy published his first paper, "Experimental Essays on Heat, Light, and the Combinations of Light," in Beddoes' journal, and in the same year appeared Beddoes' article, "Consumption."

It was in this Bristol hospital that Beddoes discovered the exhilarating effects of nitrous oxide, and it was in it that Mr. Davy discovered the anæsthetic properties of the gas.

The work in which Beddoes' peculiar ideas are enunciated most plainly is "Considerations on the Medicinal Use and on the Production of Factitious Airs." By Thomas Beddoes, M.D., and James Watt, Engineer. Parts I., II., III. 8vo. Johnson: London, 1794–5. In the same year appeared "A Short Account of the Nature and Properties of Different Kinds of Airs, so far as relates to their Medicinal Use; intended as an Introduction to the Pneumatic Method of treating Diseases, with Miscellaneous Observations on Certain Remedies used in Consumptions." By Richard Pearson, M.D., Physician to the General Hospital near Birmingham, and Member of the Royal College of Physicians, London. 8vo. Baldwin: London, 1795.

Vapours were used for every form of disease; thus, we find Dr. John Ewart, "one of the Physicians of the Bath City Infirmary and Dispensary," publishes in 1794 "A History of Two Cases of Ulcerated Cancer of the Mamma; one of which has been cured, the other much relieved, by a New Method of applying Carbonic Acid Air." The new methods were not, however, allowed to pass unchallenged. A Dr. Robert Harrington took exception to the new views, and in 1793 he published a volume of "Chemical Essays; being a Continuation of my Reflections on Fixed Fire, with Obser-

vations and Strictures upon Drs. Priestley's, Fordyce's, Pearson's and Beddoes' late Papers in the 'Philosophical Transactions.'"

Amongst the many remedies tried by Beddoes was sulphuric ether, and he recommended its inhalation to relieve pain. In the experiments carried on in Bristol, Pearson took a keen interest, and he began to extensively use the vapour of sulphuric ether in consumptive cases. On the 1st of July, 1796, he communicated, in a letter to Dr. Simmons, F.R.S., of London, "Some Account of the Effects of the Vapour of Vitriolic Ether in Cases of Phthisis Pulmonalis." This letter was afterwards published, as was the custom, in a volume of transactions entitled "Medical Facts and Observations," in the seventh volume of which, published in 1797, the letter appears; and as the fact is often referred to, and the letter, which is a short one, is so inaccurately quoted, I give a copy, that the profession may see what position ether occupied as a therapeutic immediately before its introduction as an anæsthetic agent in surgery:—

"Having for the last two years prescribed the vapour of vitriolic ether to patients labouring under phthisis pulmonalis, and having, both in hospital and private practice, experienced the best effects from its use in this frequent and formidable disease, I am preparing to lay before the public a report of the cases in which it has been given, accompanied with remarks on some other remedies that may be employed with advantage in the cure of consumptions. Being desirous in the recommendation of a new medicine to have my own evidence supported by the concurrent testimony of other practitioners, I take the liberty of calling your attention to this subject, and of submitting to your notice my method of using this application, which is simply this—I direct the patient to pour one or two teaspoonfuls of pure vitriolic ether (or of vitriolic ether impregnated with cicuta, in the manner hereafter described) into a tea-cup or wine-glass, and afterwards to hold the same up to the mouth, and

draw in the vapour that arises from it with the breath, until all the ether is evaporated. This is repeated three, four, or five times in the course of a day, for a month or six weeks, more or less, according to circumstances.[a]

"The first effects of this application are an agreeable sensation of coolness in the chest, an abatement of the dyspnœa and cough, and, after ten minutes or a quarter of an hour, easier expectoration. The *ultimate effects* (provided other proper measures be not neglected, for this is not to supersede the use of other medicines, but to be employed in conjunction with them) are a removal of the local inflammation, a cleansing and healing of the ulcerated lungs, and a suppression of the hectic fever. To assert that all these beneficial consequences will flow from its application in every species and degree of phthisis pulmonalis would be adopting the language of quacks, and insulting the understanding of every one experienced in the profession; but to say that some of these good effects are likely to result from its use in most instances, and most of them in a great number of instances, is only asserting what an experience of two years in a situation, where the opportunities of making trial of it have been very frequent, has fully confirmed.

"[a] The loss of a part of the vapour, which is unavoidable in this mode of applying it, may be prevented, as a medical friend has suggested, by setting the tea-cup containing the ether in a small basin, and inverting a funnel over it. By applying the mouth to the tube of the funnel, and making an inspiration, the patient draws in all the vapour along with the atmospheric air, which enters at the bottom of the funnel. In winter the evaporation may be promoted by setting the tea-cup in hot water, in which case the funnel is to be inverted, *not* into the basin containing the water, but over both the tea-cup and basin, so as to rest immediately upon a table, tray, or plate, having a bit of doubled paper or a quill put under it, to allow the external air to enter more freely.

"Children, and even infants, may be made to inhale this vapour by wetting a handkerchief with ether and holding it near the nose and mouth. It must be confessed that this is attended with great waste; but in urgent cases of whooping-cough and croup, in which it promises to be of use, this consideration can have little weight."

"The salutary operation of ether applied to the lungs in the form of vapour, I have found to be greatly promoted by several volatile substances that are soluble in it; but by none more so than by cicuta. By macerating a sufficient quantity of the dried leaves of this plant in ether for the space of three or four days, or, at most, a week, and occasionally shaking them together, a very saturated tincture is obtained, which may be inhaled in the same manner, and in the same doses, as the pure ether. My proportions are a scruple or half a drachm of the powdered leaves to every ounce of ether. The narcotic particles of the cicuta, conveyed in this manner along with the ether-vapour to the diseased lungs, act as a topical application, with the best effect; hence, ether thus impregnated succeeds in most instances better than when it is employed alone. The only unpleasant circumstance attending the inhalation of the etherial tincture of cicuta is a slight degree of sickness and giddiness, which, however, soon go off.

"It cannot be expected that I should here point out every symptom, or set of symptoms, which indicate or forbid the use of this application. I shall only remark, that it appears to be best suited to the florid, or what is commonly termed the scrophulous consumption. Where the pulmonic affection is complicated with mesenteric obstruction, or diseases of the other viscera, or a dropsical condition, it affords but transitory relief; and in the very last stage of the disorder the proper time for using it is past.

"Should you be induced, sir, by this address to make trial of the vapour of vitriolic ether impregnated with cicuta in phthisical cases, I shall be glad to be favoured with your remarks and observations upon it, whether in its favour or not.

"N.B.—In catarrhs the ether-vapour without the cicuta succeeds very well. In these cases it is seldom necessary to continue the inhalation more than three or four days, or a week at farthest."

Bristol was the principal port for American trade, and we need not be surprised to find inhalation of ether-vapour recommended by Dr. Warren, of Boston, for phthisis in 1805—about which time Dr. Woolcombe, of Plymouth, was using it. In 1815 Nysten recommended the inhalation of ether vapour.[a] Faraday, who acknowledged the authorship of the article on ether-vapour in the *Quarterly Journal of Science*, thus wrote in 1818:—"A convenient mode of ascertaining the effects of ether is obtained by introducing a tube into the upper part of a bottle containing ether, and breathing through it. A stimulating effect is at first perceived at the epiglottis, but soon becomes very much diminished; a sensation of fulness is then generally felt in the head, and a succession of effects similar to those produced by nitrous oxide.

"By lowering the tube into the bottle more of the ether is inhaled at each inspiration, the effect takes place more rapidly, and the sensations are more perfect in their resemblance to those of the gas. In trying the effects of the ethereal vapour on persons who are peculiarly affected by nitrous oxide, the similarity of sensations was very unexpectedly found to have taken place. One person, who always feels a depression of spirits on inhaling the gas, had sensations of a similar kind produced by inhaling the vapour."

The necessity for due care in the administration of the ether-vapour did not escape the attention of Faraday. He writes as follows:—"It it necessary to use caution in making experiments of this kind (ether inhalation). By imprudent inspiration of ether a gentleman was thrown into a very lethargic state, which continued, with occasional periods of intermission, for more than thirty hours, and great depression of spirits for many days; the pulse was so much lowered that considerable fears were entertained of his life."

[a] Dict. des Sciences Méd. Vol. XIII.

Physicians, after ether-vapour had attained so much repute, commenced an indiscriminate use of medicated inhalations.

In 1829 Dr. James Murray published at Longmans his "Practical Observations on the Inhalation of Iodine and various Vapours in Consumption, Catarrh, Croup, Asthma, and other Diseases." Horatio Potter, the following year, published a volume on the "Inhalation of Diluted Chlorine in the Early Stages of Pulmonary Consumption."

Dr. Humphrey's book on "Medicated Vapours" appeared in 1831, and during the same year Sir Charles Scudamore published his book of "Cases illustrative of the Efficacy of Various Medicines administered by Inhalation in Pulmonary Consumption; in certain Morbid States of the Trachea and Bronchial Tubes, attended with Distressing Cough; and in Asthma."

The profession and the public had thus become quite familiarised with inhalations, and we are prone to give the experimenters with ether and chloroform an undeserved credit for courage; they were simply doing what numerous others were doing—testing the properties of the medicine by inhalation, they were unconscious of danger. Dr. J. D. Mitchell writes[a]—"Some years ago a practice obtained among the lads of Philadelphia, of inhaling the vapour of sulphuric ether by way of sport. A small quantity, placed in a bladder, was almost instantly converted into vapour by the application of hot water. By means of a tube and stop-cock, the gas could be easily inhaled. In some instances the experiment excited mere playfulness and sprightly movement, but in several cases delirium and even phrenitis was induced, which ended fatally."

A similar practice was customary in Anderson, South Carolina, and in one of their mischievous moods the boys got hold of a negro lad, who, being held down, was forcibly put under the effect of the

[a] Mitchell's Chemistry, p. 172. Beck's Jurisprudence, p. 944. Albany. 1835.

ether-vapour; complete anæsthesia resulted, and the boys were terribly frightened. One of them, Wiehite, long afterwards told the story to the gentleman with whom he was serving his time—Dr. Long, of Jefferson, Georgia—and Long determined to try the effect of ether-vapour as an anæsthetic. An opportunity soon afterwards offered, and Long, in March, 1842, etherised a patient from whom he painlessly removed a tumour.

From deficient inter-State communication in 1842, Dr. Long's operation remained unknown until the 1847 controversies of Wells, Morton, and others, caused the past records to be examined.

Two deaths from the inhalation of the vapour of nitrous ether in 1830 excited considerable attention. One of them was reported by a gentleman in April, 1830, to the Royal Institution, London; and an account of the other was copied from the report of the coroner's inquest, which appeared in a local paper, into the second volume of the *Midland Medical and Surgical Reporter*, and summarised on page 452 of the thirty-fifth volume of the *Edinburgh Medical and Surgical Journal*. They are referred to both by Christison[a] and by Beck, and as they are cases of considerable interest I give them as reported:—"A carboy of nitric ether, which was kept in the bedroom of a servant, burst during the night; the vapour filled the room, there was no fireplace, and the door was shut. In the morning the occupant of the room was found dead in bed."

The second case is that of "a female, in the service of Mr. Thomas, druggist, at Hay, Breconshire, went to bed in perfect health, but did not rise the next morning at her usual hour. On going to call her the door was found fastened, and on breaking it open she was seen dead, lying on the right side, with arms folded across the breast, as in profound sleep, and the features calm.

[a] Christison on Poisons. 2nd Edition. Edinburgh: 1832. Beck's Jurisprudence. Albany: 1835.

"The body was opened in the presence of three surgeons. The coats of the stomach were a little inflamed, and it contained a little fluid. The intestines were turgid, and the lungs gorged; the uterus was found impregnated, and bearing a three months' male fœtus. The dissection proceeded no further, and the suspicion that had been entertained that poison had been swallowed was removed by the discovery that in the room was a broken jar, which had contained three gallons of nitric ether, and the ether spilled about the room. The apartment being small, and the atmosphere strongly impregnated with this vapour, the medical witnesses were of opinion that the effluvia caused her death, and such was the verdict of the coroner's jury."

The editor of the *Midland Medical and Surgical Reporter* states that he is acquainted with an instance where effects of the same description, though not absolutely fatal, were produced by the inhalation of an atmosphere loaded with the vapour of sulphuric ether. The individual—a young man—fell into an insensible state, remained apoplectic for some hours, and would undoubtedly have perished had he not been removed in time from the noxious atmosphere. Dr. Christison, now Sir Robert, quotes a somewhat similar instance—that of a gentleman who, in consequence of inhaling sulphuric ether too long, was attacked with an intermitting lethargy for thirty-six hours, depression of spirits, and lowness of pulse.

The editor of the *Edinburgh Medical and Surgical Journal*, commenting on these cases, says:—"There can be no question, then, that the inhalation of air much loaded with these vapours will prove highly dangerous. . . . The woman seems to have died, as in cases of poisoning from carbonic acid, from slow obstruction of the breathing—from gradual asphyxia."

A monument in Boston, Mass., to William Thomas Green Morton bears the following inscription :—

"To commemorate the discovery that the inhaling of ether causes insensibility to pain. First proved to the world at the Massachusetts general hospital in Boston, October 16th, 1846."

CHAPTER V.

Jackson's Claims to the Introduction of Ether Anæsthesia considered—Morton's Application of Ether to Dentistry—Operations of Warren and Hayward in America—First Operation under Ether Anæsthesia in England—In Ireland—Dr. McDonald's Experiment on Self—Dr. Hargrave's Case—The Jackson, Morton, Wells, Dispute concerning Priority—The Bigelow-Simpson Dispute—Fatal Results from the Careless Administration of Ether—Rectal Administration of Ether Vapour—Dupuy—Johnson—Miller—Antidotes.

Thus, in 1831, we see that the profession knew of the power of ether-vapour, and how to combat its injurious effects, but it was not until the 30th of September, 1846, that Dr. Jackson produced unconsciousness in himself for eight minutes by the clock, with the vapour of sulphuric ether. We cannot believe that such a distinguished chemist as Jackson was could have been ignorant of Pearson's, Beddoes', and Faraday's experiments with sulphuric ether-vapour, or with the cases recorded above, for they were reported by Beck in his "Jurisprudence," which was published in Albany, New York State, in 1835; and we know that he was familiar with Sir Humphrey Davy's experiments with nitrous oxide gas, for he prepared the anæsthetic for Wells, Morton's partner.

Be that as it may, Jackson suggested to Morton that ether was suitable as an anæsthetic for teeth extraction, as he had experienced in himself the anæsthetic effects of its vapour, and Morton determined to test the value of the substance on the first opportunity. A suitable case occurred almost immediately after he had made his resolve, and the very same day, under the influence of ether-vapour, the aching tooth of Eben Frost was painlessly extracted. The astonishing and epoch-making fact was quickly

made known throughout Boston, and on the 16th of October, 1846, Morton, at the request of the medical staff, gave ether-vapour to a patient in the Massachusetts General Hospital, from whom Mr. J. C. Warren removed a vascular tumour of the neck; and on the 6th of November of the same year Mr. Hayward amputated painlessly the leg of an etherised patient.

American surgeons lost no time in acquainting their European brethren of the great discovery. Drs. Bigelow and Ware wrote to Dr. Boot, of Gower-street, London, telling him of the pain-preventing powers of ether-vapour; and on the 19th of December, 1846, Mr. Robertson, a dentist, at the request of Dr. Boot, removed some teeth from an anæsthetised patient. This is considered to be the first operation performed under ether-anæsthesia in England.

On the 20th of January, 1847, the following paragraph appeared in the *Medical Press*, and it tells how quickly the new remedy was adopted:—"*The Etherisation for Surgical Operations.*—The innumerable reports of the successful application of this discovery seem already to leave no reasonable doubt as to its value or of its safety in a great majority of cases, and as yet no fatal, or even alarming result, has followed its use. Hundreds of operations have been performed after the inhalation, and in at least a large proportion they have been performed without pain, and, what is nearly of equal importance, without cry or struggle. In some, it is of course to be admitted, the agent has not only not caused the necessary amount of insensibility, but, on the contrary, a state of excitement altogether forbidding any operation; and in others, though very rarely, it has had little effect in any way except leaving behind that state of nervous system which follows the use of alcohol by persons who resist its influence. An attempt is being made to restrict the use of this agent by patent. We are convinced that this can never be effected except to secure the invention of some particular inhaler.

We wish the discoverer may have every legitimate advantage to which he is entitled, but any attempt to monopolise medicinal remedies must be resisted."

We could have no stronger proof of the shortness of memory on the part of the profession than the fact that the unconsciousness produced by the inhalation of sulphuric ether-vapour was spoken of here as if it were a new discovery. And on the 16th of January, 1847, Mr. James Robinson, dentist, of 7 Gower-street, London, who performed the first operation in England on an etherised patient, published his method of inhalation in the *Medical Press*. The first operation performed on an anæsthetised patient in Ireland was done on the 1st of January, 1847. The patient—Mary Kane, aged eighteen years, a healthy country girl from the neighbourhood of Drogheda—had her arm amputated in the middle third for an injury received in her elbow-joint.

A short time prior to the operation Mr. Hutton had read Dr. Forbes' article in the *British and Foreign Medical Review*, on the new anæsthetic, ether, and brought the article under the notice of Dr. J. M'Donnell, of 4 Gardiner's-row, Dublin, the father of Dr. Robert M'Donnell, who performed the operation in the Richmond Surgical Hospital. The operator was assisted by Carmichael, Hutton, Adams, and Hamilton. The first attempt to produce anæsthesia failed, but the second succeeded admirably, and the patient afterwards declared she had felt no pain.

Before Dr. M'Donnell submitted his patient to the risk of anæsthesia, he submitted himself "five or six times" to the insensibility of ether-inhalation—a fact which redounds both to his credit as a gentleman and his caution as a surgeon.

The case was discussed at a meeting of the Surgical Society on the 9th of January, 1847, and it elicited some interesting observations. Mr. Hargrave mentioned "the case of a young girl of

sixteen or eighteen, who came under his observation some years ago, and on whom ether had a very remarkable effect. After an illness of some length, she was seized with spasmodic attacks of a violent tetanic character, for which there was no assignable cause. . . . Happening on one occasion, at the approach of a fit, to observe some ether by her bedside, I placed a little of it in the palm of my hand, which she inhaled with the immediate effect of arresting the laryngeal spasm and the tetanic spasm. For a week or ten days she used this remedy with much benefit." Dr. Henry Kennedy drew attention to the similarity in effect of sulphuric ether-vapour and that of nitrous oxide gas, and gave it as his opinion that anæsthetics were unsuited in cases of cardiac and pulmonary diseases.

Ether quickly became universally used, and that in the most reckless manner. A committee, consisting of Drs. M'Donnell, Tufnell, and Bellingham, appointed by the Surgical Society of Ireland, declared it should be used with care in all cases, and was unsuited for cases of disease of the heart and pulmonary lesions; any person, however, was deemed competent to administer it, and there is no telling how much damage it might have done if it had not been displaced by chloroform.

The great success of the drug caused Jackson and Morton to attempt to secure a patent for it, and this called forth Wells' protest, in support of which he put forward his claim to be considered the discoverer.

Mr. Wells' pamphlet ("A History of the Discovery of the Application of Nitrous Oxide Gas, Ether, and other Vapours to Surgical Operations," 12mo, pp. 25) was issued on the 30th of March, 1847. Wells bases his claim on the fact that he extracted a tooth from a patient who was under the anæsthesia of nitrous oxide gas before Dr. J. C. Warren's surgery class in the Boston School of Medicine as early as 1844, and that Morton was his pupil.

Morton's claims were defended against all comers by Mr. Edward Warren in a pamphlet entitled, "Some Account of the Lethean; or, Who is the Discoverer?" By E. Warren. With a Supplement. 8vo, pp. 88. Boston, 1847. It appeared in May, 1847, and he asserts that an obstinate patient of Morton's refused to have a tooth extracted unless it could be done painlessly, and that he in conversation with Jackson reminded him of the inhalation of ether-vapour by the students at college, and asked did he think such a remedy would suit their purpose. Jackson approved of the suggestion, and recommended Burnett's ether as the best for the experiment.

To me it appears that Jackson knew of the effects produced with the agent by the English experimenters, and recommended ether-vapour, after first having tried it himself, to Morton. At all events, Morton is not deserving of much sympathy. His first attempt was to procure a patent, giving Jackson ten per cent. to keep quiet—a fact which does not give much support to his claim to be considered the discoverer.

Discussion on the subject of ether was not confined to America. Dr. Bigelow, of Boston, attacked Sir James Young Simpson for taking to himself undue credit for the introduction of anæsthesia into surgery. Simpson, however, fully established his claim to the merit of having introduced ether-anæsthesia into the practice of midwifery—his first case occurred on the 19th of January, 1847, and was shortly afterwards reported in the medical journals.

No person could have thought that ether was to be so quickly and completely displaced. But, in truth, the profession had got a craze for testing all manner of vapours, and the smell of ether was both unpleasant and suffocative, and many untoward effects—delirium, bronchitis, and even death—came to be justly credited to the indiscriminate use of the agent.

The observations of the Editor of Ranking, made in 1847, are so

appropriate that I think them worth being recalled—"The real danger to which it (ether) is exposed arises from the precipitate encomiums of its friends, and the reckless manner in which it appears to be made use of, with reference to and by persons utterly incapable of judging of the normal or diseased physical peculiarities of the patient."

One of the first recorded deaths from ether-vapour was that of Thomas Herbert, who died about forty-eight hours after a lithotomy operation, performed in the Colchester Hospital, in February, 1847, by Mr. Roger Nunn, and reported by him in the *Medical Gazette* of the 5th of March following.

On the 16th of February, 1847, M. Jobert, of the St. Louis Hospital, Paris, brought before the Academy of Medicine an account of two cases of death from ether which had occurred in his practice, and on the 12th of March of the same year the Editor of the *Medical Gazette* mentioned that he was already "aware of six or seven deaths" from ether-vapour, and refers to the frequency of "great excitement of the nervous system, sometimes approaching to apoplexy, an asthmatic condition of the respiratory organs, spitting of blood, syncope, as amongst the results of ether inhalation."

These accidents, of course, led to other methods being adopted, and M. V. Dupuy, in the *Gazette Medicale* of the 12th of April, 1847, suggested the administration of the ether-vapour *per anum*, stating that in some experiments on dogs and rabbits he had found that method of administration to produce all the good effects without any of the unpleasantness of the oral method.

Dr. J. T. Johnson had the same idea as M. Dupuy; he put the method to the test, and reported very unfavourably of it in the *Madras Spectator*.

The *Lancet* of the 10th of July gives the following case from Dr. Johnson's reprint:—"A. B., European, a strong, healthy-

looking man, having hydrocele on the left side of about one year's standing, presented himself at my house for operation on Thursday, the 1st of April, and wished to be put under the influence of ether previously. Having, on the day previous, as recommended by Assistant-Surgeon Crawford, used the vapour of ether as an enema by way of experiment, on three dogs, with the effect of producing symptoms of drunkenness, attended by vomiting and apparent diminution of sensibility in each case, I considered the present a fair opportunity of trying it in this way on the human subject. I put an ounce of ether into a common bladder with an ivory pipe, placed the bladder in hot water, and forced the vapour into the rectum as it evaporated. The patient immediately complained of much uneasiness, said he felt as if I were throwing boiling lead into him, was griped, and tasted the ether in his breath. His breath also smelt strongly of it. In a few minutes he felt so much distended, was griped, and felt altogether so uncomfortable, that he made me discontinue the injection, saying that he would rather suffer the pain of the operation than go on with it."

Antidotes for ether-vapour came to find a place in the surgeon's armentarium, and on the 29th March, 1847, Mr. James Robinson recommended the use of oxygen gas, which Dr. (now Sir William) Gull declared to be useless. Artificial respiration and small bleedings were adopted, and every hospital found it necessary to arm itself with antidotes against an agent which a few months previously was declared to be perfectly reliable as an anæsthetic, and wholly free from danger.

This practice has been revived, and, under the title of Yversen's Method, has been advocated before the Philadelphia County Medical Society by Dr. John S. Miller,[a] who, after reporting four cases in which it was used, concludes that in this method of etheri-

[a] Therapeutic Notes. Medical Press. Vol. XCIII., p. 166. 1st Sept., 1888.

sation the most obvious advantages are as follows:—1. Dyspnœa is avoided, and the patient is saved from the anxiety due to a sense of impending suffocation. 2. There is avoided the danger of simultaneous irritation of the superior laryngeal and pneumogastric nerves at the periphery—these irritations neutralising each other in the respiratory centre, and suspending respiration entirely. 3. The danger of asphyxia is lessened—the patient not being drowned in his own mucus, and the integrity of the pulmonary mucoos membrane as an organ of gas exchange is preserved. Of course some vapour finds itself in the lungs, and acts there as a local irritant—elimination being by that channel, but the quantity is not great, and does not constitute a source of danger. In the case reported the increase in secretion was too trifling for discovery. 4. The stage of excitation is therefore not prolonged by the struggles for breath. In general, it may be said that the delirium of any alcholic intoxication is a pleasant and good-natured one, unless the patient is crossed—as he certainly feels himself to be when a wet towel is pressed over his face.

CHAPTER VI.

Methyl Chloride—Methylene Dichloride—Trichlormethane or Chloroform—Tetrachlormethane or Carbon Tetrachloride.

"TAKING it all in all, it (methylene) is the handiest, readiest, and best of the whole of the anæsthetic series." Such is Dr. Richardson's summary of Sir Spencer Wells' opinion of methylene—one of the few chemicals, besides ether and chloroform, that have come into use as general anæsthetics.

Since the introduction of the drug it has been largely used both by Dr. Richardson and Sir Spencer Wells, and the name has been abbreviated from bichloride of methylene to that of methylene.

The chemical is one of the marsh gas (CH_4) series, in which chlorine is made to displace the hydrogen of the compound. Anæsthetic properties are claimed for the whole series, from monochloride of methene to the tetra-chloride of carbon, and the following brief account of methene, methylene, or methyl, also called methyl hydride, will assist in showing the relationship between the different chlorides of methene, of which chloroform is a member.

Methene has the composition CH_4, it is a colourless, inodorous gas, commonly called "Marsh Gas," and has been known from the earliest ages. Basil Valentine recognised its presence in mines; Libarius very fully notices it, and wrote of its explosive property; Volta, in 1777, pointed out its inflammable character, and in 1785 Berthollet described not only its physical properties, but also its chemical composition.

The chlorides of methene (CH_4) are four. Methyl chloride (CH_3Cl), the first of the series, contains one atom of chlorine which

has displaced an atom of hydrogen, and so differs from methene. The chloride is prepared as a gas in Paris, and compressed into iron cylinders of the form of those in which nitrous oxide is generally supplied to dentists. As the gas is emitted from the cylinder, it is mixed with a stream of atmospheric air, and being applied as a jet, it freezes the part by the intense cold it produces.[a] It was discovered by Dumas and Péligot, and advantage of its power of producing artificial cold has latterly been turned to account in medicine. In the year 1887, at a meeting of the Société Médicale des Hôpitaux, M. Deboe read a paper on the use of chloride of methene (CH_3Cl). Since 1884 he had treated one hundred and fifty cases of sciatica with the chemical, and found only five per cent. of the cases not benefited by it. Lumbago and neuralgia are quickly cured by it, as is also facial neuralgia. Patients whose skins are irritable, and those suffering from diabetes or albuminuria, are unsuitable subjects for its application. The drug may be sprayed on the face.

Mixed with ether, M. Raison tried the spray in M. Joffroy's ward at the Salpêtrière Hospital. The pains of locomotor ataxy were relieved by the refrigeration, the spray affording marked relief at the moment of the painful attacks. These medicaments methodically administered for a long time result in the general improvement in the state of the patient, the pains becoming less frequent and less severe. M. Raison[b] has observed that both ether spray and that of the chloride of methyl do not give good results in *tabes dorsalis* to patients who abuse the use of morphine.

Methyl dichloride, or bichloride of methylene (CH_2Cl_2), differs from the chloride in having one atom more of chlorine, and one less of hydrogen. The chemical was introduced to the profession as an

[a] Martindale and Westcott.

[b] The London Medical Record, p. 64. 1887.

anæsthetic, through the columns of the *Medical Times and Gazette* in 1867, by Dr. Richardson, who in 1868 made a report on its anæsthetic properties to the Section of Physiology of the British Association for the Advancement of Science.

Bichloride of methene, or methylene, has the disadvantage of being both expensive and difficult to preserve unchanged in its chemical composition, and as many of the samples sold as bichloride of methylene are nothing more than a mixture of chloroform and alcohol, there is much difficulty in deciding on the merits of the drug.

In the nineteenth number of the *Asclepiad*, published last autumn, Dr. Richardson reiterates his high opinion of the anæsthetic, and republishes its claims to recognition as a good general anæsthetic.

In his report to the British Association, Dr. Richardson wrote as follows :—" In my last report I described that the bichloride of methylene (CH_2Cl_2) was an excellent anæsthetic substance, and for many reasons preferable to chloroform. I have since confirmed this view fully by practice. After subjecting myself to the action of the vapour to the production of perfect insensibility, I ventured to administer it for surgical purposes on the 15th of October last, 1867. The sleep produced was of the deepest and gentlest character, and the operation performed by Mr. Spencer Wells, and which lasted thirty-five minutes, was quite painless. One trifling difficulty only stood in the way—the air of the room being warm, and the fluid having a low boiling-point, the water from the breath of the patient, with which the inhaler was saturated, became frozen, and was somewhat troublesome." The difficulty occasioned by the low boiling-point of the liquid has been overcome by the use of Junker's inhaler, by means of which he generally produces "good narcotism in five minutes."

The physiological effect of the drug differs, according to Dr. Richardson, from that of chloroform in several particulars, to wit:— "The anæsthetic sleep is produced more quickly, and when produced is more prolonged. On the other hand, recovery, when it commences, is far more rapid; indeed, the period of recovery, according to my experience, is never extended over four minutes, and there are no tedious or painful after-effects. "When animals are allowed to sleep to death in vapour of bichloride of methylene, the lungs are found containing blood on both sides. In this respect the vapour acts differently from both chloroform and ether."

The preparation used in Dr. Richardson's cases is that of Messrs. Robbins, which is manufactured by the action of chloroform on zinc. Its high price is due to the difficulty of preparing it, owing to its low boiling-point.

In an address delivered before the British Medical Association at Manchester, on the 9th of August, 1877, by T. Spencer Wells (now Sir T. Spencer Wells), F.R.C.S., he thus expressed himself on the advantages of methylene:—"In 1872 I made known my opinion that all the advantages of complete anæsthesia could be obtained by the use of bichloride of methylene, or chloro-methyl, and with fewer drawbacks than by any other known anæsthetic. That was the result of an experience of five years, and of 350 serious operations. The experience of the five succeeding years up to the present time, with more than 600 additional cases of ovariotomy, and many other cases of surgical operations, has fully confirmed me in this belief. Given properly diluted with air, the vapour of chloro-methyl has, in my experience of ten years, with more than 1,000 operations of a nature unusually severe as tests of an anæsthetic, proved to be, without a single exception, applicable to every patient, perfectly certain to produce complete anæsthesia, relieving the surgeon from all alarm, or even anxiety, and its use has never

been followed by any dangerous symptom which could be fairly attributed to it."

Sir Spencer uses Junker's apparatus for the administration of the bichloride.

American surgeons gave the anæsthetic a trial. Mr. A. R. Strahan, of New York (*Medical Record*), after some successful experiments with the vapour on himself, used the bichloride in a surgical case, and in one of labour, with success. The surgical case necessitated anæsthesia to be continued for three-quarters of an hour, and an ounce and a half of methylene was used. In the case of labour a drachm and a half of the bichloride was sufficient to anæsthetise the patient. Both in the surgical and in the labour case the drug was administered from a folded napkin.

Dr. Dudley Wilmot Buxton[a] writes that "Methylene acts precisely like chloroform, and its use is fraught with dangers which differ not in kind, but in degree, from those present when chloroform is used."

Dr. Buxton does not credit bichloride of methylene (CH_2Cl_2) with anæsthetic properties, and he quotes the opinion of the French chemists—Regnault and Villejeau, to wit—"That the pure substance (bichloride of methylene) is not an anæsthetic, but a powerful convulsant, and proves fatal to animals in a few seconds."[b] Believing the methylene of commerce to be nothing more than "diluted chloroform," he naturally directs that "both the respiration and the pulse must be sedulously watched, and the utmost vigilance displayed to avoid accumulation of vapour in the lungs."

Dr. Henry M. Lyman says the effects of the bichloride of methylene (CH_2Cl_2) "are very similar to those of chloroform

[a] Anæsthetics; their Uses and Administration. 1888.

[b] P. 102, *ut supra*.

inhalation."[a] He ascribes the evanescent character of its effects to its low boiling-point, and makes the following statements, to wit—"Four cubic centimetres are sufficient to produce insensibility. No unpleasant sensations ordinarily accompany the return to consciousness. Vomiting is less frequent than after chloroform or ether."

Anything like an accurate estimate of the percentage of deaths caused by the bichloride is almost impossible to make. Dr. Andrews, of Chicago (1877) gives one death from bichloride of methylene in 7,000 cases; Dr. Coles, of Virginia, reported two deaths in 10,000 inhalations of the bichloride. But until we know what drug was really used, the statistics are worthless. Was the agent used a mixture of chloroform and alcohol, or pure bichloride of methylene?

Martindale and Westcott[b] write of methylene:—"A commercial sample (bichloride of methylene) had sp. gr. 1·326; it is said to be chloroform reduced to this density by alcohol."

Until a good commercial sample of the bichloride of methylene (CH_2Cl_2) is procurable at a reasonable price, the anæsthetic will remain comparatively unknown. The advantages claimed for it by its friends are not sufficient to override the question of cost.

Trichloride of methene, or methyl ($CHCl_3$), is the familiar anæsthetic chloroform. It differs in its chemical composition from the bichloride in having one atom more of chlorine, and one less of hydrogen.

Tetra-chloride of methene, or methyl-carbon tetra-chloride (CCl_4), has four atoms of chlorine, all the hydrogen of the base methen having been displaced by chlorine. The drug much resembles

[a] Anæsthetics and Anæsthesia. By Henry M. Lyman, A.M., M.D.; Professor of Physiology and Diseases of the Nervous System in the Rush Medical College, Chicago, Ill. International Encyclopædia of Surgery. Vol. I. 1882.

[b] The Extra Pharmacopœia. Fifth Edition. 1888. Page 249.

chloroform. It is a transparent, colourless liquid of a sp. gr. 1·599; boiling-point, 170·6° F. (M. Regnault); vapour density, 5·33. It has an agreeable aromatic flavour, and an odour not unlike that of the quince (P. Smith).

The chemical was discovered in 1839 by M. Regnault, and its anæsthetic properties were made known by Drs. A. E. Sansom and John Harley in 1864.[a] They recorded the results of their experiments in Dr. Sansom's work on "Chloroform," published in 1865. Sir James Young Simpson, independently working, also found that the tetra-chloride—for which he suggested the name, "Chlorocarbon"—had well-marked anæsthetic properties (The *Medical Times and Gazette*, December, 1865).

As might be expected from the chemical composition of the tetra-chloride of methen, its effects much resemble those of chloroform, and Sir J. Y. Simpson thus writes of it:—"Its (tetra-chloride of methene) primary effects are very analogous to those of chloroform, but it takes a longer time to produce the same degree of anæsthesia, and generally a longer time to recover from it. . . . . The depressing influence of chloro-carbon upon the heart is greater than that of chloroform, and consequently I believe it to be more dangerous to employ as a general anæsthetic agent. In a case of midwifery, in which it was exhibited . . . . for above an hour, with its usual anæsthetic effects, the pulse latterly became extremely feeble and weak. In another, in which it was exhibited by Dr. Black, the patient, who had taken chloroform several times before, was unaware that the new anæsthetic was different from the old; her pulse continued steady and firm, although she is the subject of valvular disease of the heart. The surgical operations in which I have used chloro-carbon have been the closure of a vesico-vaginal fistula, the division of the cervix-uteri, the enlargement of the

[a] British and Foreign Medico-Chirurgical Review, 1867.

orifice of the vagina, and the application of potassa fusa to a large, flat nævus upon the chest of a young infant. In all these cases it answered quite well as an anæsthetic. The child did not waken up for more than an hour and a half after the employment of the caustic, which was used so as to produce a large slough. Its pulse was rapid and weak during the greatest degree of anæsthetic sleep. . . . . Chloro-carbon, when applied externally to the skin, acts much less as a stimulant and irritant than chloroform."

Tetra-chloride of methene is recommended as an anæsthetic in nervous headache, neuralgia, tic douloureux, toothache, pains of dysmenorrhœa, and the heaviness, which is apparent immediately on awakening, rapidly passes away. Dr. Lauder Brunton[a] states that it does not produce any bad after-effects.

[a] Text-Book of Pharmacology, Therapeutics, and Materia Medica. By T. Lauder Brunton, M.D., D. Sc., F.R.S. Third Edition. 1887.

CHAPTER VII.

Butane — Rhigolene — Ethylene — Amylene — Ethyl-nitrate — Aldehyde — Carbon Bisulphuret — Ethidene Dichloride — Ethyl Bromide — Carbon Di-oxide.

The list of chemicals that have been introduced as general and local anæsthetics since Guthrie discovered chloroform is a very long one, and the following list will show that many drugs were tested in the search for a substitute for the much-abused chloroform and unpleasant smelling ether:—

Butylic hydride, butane, diethyl (C_4H_{10}), obtained by fractional distillation from petroleum dissolved in naphtha, the solution constitutes *rhigolene*—a colourless liquid which evaporates with great rapidity, boiling in the palm of the hand. It has been used for the production of local anæsthesia by the evaporation of its spray.

Ethylene, olefiant gas, elayl, heavy carburetted hydrogen (C_2H_4) has been tried as an anæsthetic. In 1849 Mr. Thomas Numeley (*Transactions of the Prov. Med. Ass.*) used olefiant gas as an anæsthetic in a midwifery case with rigid os, and on three patients in the Leeds Infirmary. The first, a case of Mr. Smith's, was fifty-five years of age, he suffering from rigidity of the abductor muscles of the thigh; four scruples of the substance were consumed by him during the operation. The second, a case of Mr. Teale's, a man, aged forty-two years, with a malignant tumour; two scruples sufficed for the operation. And the third, a patient of Mr. Heys', aged fifteen years, whose hamstring muscles were divided. In all four the results were satisfactory, but subsequent practice has shown that continued inhalation produced dilatation of the pupils, muscular relaxation, vomiting, and death.

Amylene, pentylene, pentene (C_5H_{10}). "The condition of insensibility produced by the inhalation of its vapour is less persistent than the effect of chloroform. Muscular spasms are likely to occur under its influence. Snow administered it in more than one hundred cases; but two deaths occurring as a consequence of its use, it was entirely abandoned."

Nitrate of ethyl,[a] a transparent, colourless liquid, with a sweet taste and an agreeable odour; sp. gr., 1·112. Is pleasant and easy to inhale, and possesses very rapid and powerful anæsthetic properties. A small quantity, such as fifty or sixty drops, when sprinkled on a handkerchief and inhaled, produces insensibility after a few inspirations. But during the brief period which elapses before the complete anæsthesia is induced, the sensations of noise and fulness in the head are in general excessive, and much headache and giddiness have usually followed its employment, and persisted for some time.

Aldehyde (C_2H_4O). Professor Poggiale, of Paris, recommended aldehyde as an anæsthetic superior to ether and chloroform. It, however, produces much bronchial irritation, and an insufferable feeling of dyspnœa. "The sensations of difficult respiration and constriction of the chest which the vapour produced, resembled precisely those of a severe fit of spasmodic asthma." It is stated to act as a depressant to the heart.

Bisulphuret of carbon (CS_2) has been used as an anæsthetic. Simpson[b] found it to be a very rapid and powerful anæsthetic, though difficult to manage. In some patients it produced depressing and disagreeable visions, and headache and giddiness in all. With the great majority of patients, however, its very offensive smell would preclude its use.

[a] Sir J. Y. Simpson. Anæsthesia. 1871.

[b] *Ut supra.*

Besides these preparations many mixtures have been suggested for use. Turpentine has been put forward as a valuable addition to chloroform, but the principal mixtures in use are those of chloroform and alcohol, or chloroform, ether, and alcohol.

To diminish the risk in cases of cardiac asthenia, the addition of nitrite of amyl to chloroform in the proportions of two drachms of the nitrite to a pound of the chloroform was recommended; the combination did not, however, become popular, and has almost dropped out of use.

Ethidene dichloride, dichlorethene, monochlorethyl-chloride, chlorinated chloride of ethyl (CH_3CHCl_2) was first prepared by Regnault,[a] by acting with chlorine on ethyl chloride.

It is an ethereal-smelling liquid, having a sweet and biting taste; sp. gr., 1·2. It boils at 135° to 150° F., and at 0° has a specific gravity of 1·2044, and is a very stable compound.

It was first used as an anæsthetic by Dr. Snow, and is said by some to be a much safer anæsthetic than chloroform.[b] "Compared with chloroform, dichloride of ethidene is pleasanter, more rapid in action, causes no excitement during or after administration, more rapid recovery from it, and altogether there is less danger attending its use. Children require about one drachm, adults four or five drachms."—Binz.

This very favourable report has not convinced the profession that ethidene possesses any particular advantages over chloroform.

Dr. Sydney Ringer[c] writes, "I find that chloroform and ethidene dichloride about equally poisonous to the heart's substance."

The Glasgow Committee of the British Medical Association, on the Action of Anæsthetics, reported (*British Medical Journal*, 1879)

[a] Roscoe and Schorlemmer. Vol. III. P. 2.

[b] Extra Pharmacopœia. Fifth Edition. 1888.

[c] A Handbook of Therapeutics. By Sydney Ringer, M.D., F.R.S. Twelfth Edition. 1888.

that "Ethidene did not produce sudden or unexpected depressions of the blood-pressure." The anæsthetic has, however, been credited with at least two deaths, and it has never come into general use.

The *British Medical Journal*, December, 1882, p. 1,267, gives an account of the death of a young man, twenty-six years of age, who was put under dichloride of ethidene, in the Liverpool Eye and Ear Infirmary. In about ten minutes he became anæsthetised, and the operation was commenced; almost immediately the pulse became very feeble, and every effort to restore the patient was fruitless.

Ethyl Bromide (C_2H_5Br.) was first prepared by Serullus in 1827, by gradually adding bromide to a mixture of alcohol and phosphorus. Personne suggested the use of amorphous phosphorus, as less dangerous than ordinary phosphorus, and more convenient to manipulate.

Bromide of ethyl is a colourless mobile liquid of an agreeable odour and a hot saccharine taste. Its specific gravity is 1·47, and its boiling point 104° F.; vapour density, 3·754. It burns when ignited with a fine green smokeless flame, evolving vapours of bromine.

It is very sparingly soluble in water, freely soluble in strong alcohol and ether. When a small portion is evaporated from a porcelain plate by causing it to flow to and fro over the surface, little or no foreign odour is yielded as the last portions pass off, and the plate is covered with a slight deposit of moisture.

When, in 1849, Mr. Thomas Numeley,[c] of Leeds, was conducting his experiments on anæsthetics, he examined bromide of ethyl, and it was employed by him on the human subject several times, for different operations, with success. The great expense of its then production caused him to discontinue its use, but in

[c] Transactions of the Prov. Med. and Surg. Assoc. vol. xvi., p. 167.

1865 he again brought its claims before the profession at the meeting of the British Medical Association,[a] and claimed for it a place as one of our most valuable anæsthetics. Dr. Julian J. Chisholm,[b] of Baltimore, Md., who has employed bromide of ethyl as an anæsthetic 3,000 times without one death, writing in the *Maryland Medical Journal* of the 5th of December, 1880, and the *Philadelphia Medical News* of the 27th of January, 1883, declares that its action is so very evanescent that it can never take the place of chloroform or sulphuric ether for any serious operation requiring some time for its performance, and though he found it useful in minor operations and such as did not exceed a few minutes in their performance, yet he found that if the operation was from any cause protracted, that nausea, vomiting, and heaviness resulted. In the *St. Louis Medical Journal*, Mo., for October, 1883, Dr. Price recommends its use as superior to any other anæsthetic. In strongly recommending it, he but followed the eulogies on the substance, that Drs. Turnbull and Gowers, of Philadelphia, published in the *Phildelphia Medical and Surgical Reporter*, of the 31st of January, 1880, where, from an experience of fifteen cases, in whom anæsthetics was produced by quantities varying from three to eleven drachms of the chemical, they claim that its advantages are safeness, promptitude of action, smallness of dose, slightness of action on respiration and circulation, and no tendency to vomiting.

Dr. Terrillon (*Bulletin de Therapeutique*, April 30, 1880) tried it in four cases, and in all he found vomiting to result about two hours after the patient had recovered from the anæsthetic effects of the drug.

Dr. Mærion Symes (*Pharm. Journ.*, 1880, p. 870) thinks bromide

[a] British Medical Journal, 19th August, 1865, p. 192.

[b] Chloroform the best of Anæsthetics, p. 19.

of ethyl contra-indicated in cases of patients with diseased kidneys, or in prolonged operations.

Dr. B. F. Davenport, however (*Boston Medical and Surgical Journal*, 27th of May, 1880), considers the bromide of ethyl to be more rapid and safe than chloroform as an anæsthetic.

The chemical has, however, occasioned two deaths : one a patient of Dr. Levis (*Philadelphia Medical Times*, 5th of June, 1880), in the Jefferson College Hospital, who was being operated on for stone ; and Professor Pancoast of Philadelphia mentions in the same journal that he saw a death from its use.

Mr. W. Rogers Williams (*British Medical Journal*, March 1st, 1884) quotes Dr. Woods' (*Philadelphia Medical Times* of the 24th April, 1884) conclusion from a number of experiments with the bromide of ethyl, that "they show that bromide of ethyl may cause anæsthesia without reducing the blood pressure; but they also indicate that it is distinctly a depressent to the circulation, reducing, when in excess, the force of the blood current to a very moderate degree."

One of the difficulties in the use of the anæsthetic is the extreme rapidity with which patients under its influence regain consciousness.

Dr. P. N. Tchunikhin (*London Medical Recorder*, 15th Dec., 1885) describes his experience of bromide of ethyl as an anæsthetic in nine cases of normal and in one of instrumental (forceps) labour. The administration of the drug lasted from fifteen minutes to one hour, and the total amount in each case varied from one ounce to two ounces and five drachms. As a pain-killing means in normal labour, it acts but feebly and inconstantly—an opinion which agrees with that of Professor Peter Müller, of Berne, quoted by Dr. V. Idelson, who states that in his hands the substance was effective only in about 50 per cent. of his cases.

Recently bromide of ethyl has been again brought prominently

before the profession by Herr Schneider, dentist to the German Emperor, who recommended it at the Munich Odontological Congress of last year as an anæsthetic in dental practice; it has "since that time been employed in a large number of cases by Dr. Friederich Herz, a dental surgeon in Vienna, who contributes an interesting paper on the subject to the *Internationale Klinische Rundschau* of April 14th. He uses a simple inhaler like that of Skinner, with some cotton-wool inserted to soak up the bromide of ethyl, of which he pours in about half an ounce at first, adding a little more afterwards if required. In some cases less than seventy-five grains proved sufficient. Anæsthesia came on rapidly, usually in one or two minutes, and then was sufficient for from five to eight extractions. The patients took the bromide far better than chloroform or ether, neither struggling so much nor presenting any unpleasant symptoms after waking up. Some patients, who had previously suffered a good deal from ether, expressed themselves as highly delighted with the new drug. Dr. Herz has not tried the bromide on young children, but he thinks it will be found very suitable for them, in consequence of its not unpleasant taste and the simplicity of the apparatus required. How far bromide of ethyl would be applicable in important operations cannot as yet be stated. Blum of Bamberg, however, repeated the inhalation at a single sitting, and was enabled to extract thirty-two very firmly set roots. It may be mentioned that, according to Lewin, bromide of ethyl does not induce paralysis of the heart" (*Lancet*, 27th April, 1889, p. 848).

Many of the unpleasant effects of ethyl bromide are ascribed to impurities. Naub, of Berne, in 1887, published a valuable paper on the chemical and the methods of its preparation, an abridgement of which, by Dr. F. A. Junker, was published in the *London Medical Record* of August, 1887.

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CHAPTER VIII.

Cocaine—Discovery—Introduction—Koller's Experiments—Coca, Description of—Used by Mexicans—Coca Habit—Coquero—Hygiene—Physiological Effects of Cocaine.

On the 15th of September, 1884, at the Ophthalmological Congress at Heidelberg, Dr. Karl Koller, of Vienna, through his friend, Dr. Brettauer, of Trieste, exhibited the anæsthetic effects of cocaïne to the profession.

The alkaloid was first isolated by Gaedeke in 1855, who, in accordance with the rule of nomenclature, named it erythroxyline.

Cocaïne crystallises in large four to six-sided prisms of the clinorhombic system. Its taste is bitterish; reaction, alkaline; melting point, 208° F.; it is decomposed at a higher temperature; soluble in 704 of water, in nearly all parts of alcohol and ether. Its salts are easily soluble in water and alcohol, but not in ether. The proportion of the alkaloid found in the leaf is very variable, and, according to Squibb, seldom exceeds 0·30 per cent.

The name cocaïne was given in 1859 by Dr. A. Niemann, who thoroughly examined the leaves of the Erythroxylon Coca (Lamarck), from which it is derived. Niemann had noticed that the leaves produced anæsthesia of the tongue, and in 1874 Dr. Hughes Bennet[a] demonstrated that cocaïne was an anæsthetic.

Schroff,[b] in 1862, found that 5 centigrammes administered to rabbits gave rise to disturbance of pulse and respiration, and also produced temporary mydriasis.

[a] Edinburgh Medical Journal. Vol. XIX.

[b] Dr. William Murrell. London Medical Record. Vol. XII., p. 517.

The benumbing effects of the chewed leaves on the tongue suggested the application of a concentrated infusion of them in painful diseases of the pharynx and larynx.[a]

In 1880 Dr. Von Anrep produced a comprehensive research into cocaïne, in which he hinted that the local anæsthetising effects of the alkaloid might be made of use in general surgery. Starting on the premise that a drug which paralysed the terminal sensory nerves of the mucous membrane of the tongue could not act very differently on the cornea and conjunctiva, Dr. Karl Koller undertook a series of experiments on animals in the laboratory of Professor Stricker. His results are as follow[b]:—"If a few drops of an aqueous solution of cocaïne are dropped on the cornea of a guinea-pig, a rabbit, or a dog, or if an infusion be instilled in the usual way into the conjunctival sac, the animal blinks for a while, clearly as the result of a weak irritation. After a period of from thirty seconds to one minute the animal opens its eye, which gradually assumes a peculiar expression of rigidity. If one now touches the cornea of the animal with the head of a pin, being careful not to come in contact with the eyelashes, no reflex closure of the lid occurs, the bulb does not deviate, and the head is not thrown back, as would otherwise happen. On the contrary, the animal remains quiet, and by the employment of a stronger irritation we can convince ourselves that the cornea and conjunctiva are completely anæsthetised. For instance, I have scratched the cornea of the animals on which I have experimented with a needle, pricked the same, irritated the cornea with an induction current, which was so strong that it produced a painful sensation in the fingers and was unbearable on the tongue, and cauterised their cornea with a pencil of nitrate of silver until it became as white

[a] La Tribune Médical. 1882.

[b] Dr. Karl Koller. Lancet. Vol. II., p. 990. 1884.

as milk—all without a single movement on the part of the animals. The last two experiments convinced me that the anæsthesia included the whole substance of the cornea, and not only its surface. However, after I had cut into the cornea the animal showed decided signs of pain at the moment, when the aqueous humour gushed out and the iris prolapsed. Even in my later experiments on animals I was unable to determine whether the iris also could not be anæsthetised by the instillation of the solution into the corneal wound, or by a continued instillation into the conjunctival sac, begun and kept up for some time before the operation; for experiments testing sensibility of animals which are not narcotised are very difficult, and, especially if they are in the slightest degree complicated, are apt to give equivocal results. I had yet to find out experimentally whether cocaïne could produce anæsthesia of the inflamed cornea, and this question was answered in the affirmative when the animals on which I produced an artificial keratitis, by means of a foreign body, showed the same anæsthesia of the cornea as the healthy ones. Complete anæsthesia lasts, on the average, ten minutes when a two per cent. solution is used."

After these experiments Dr. Koller did not hesitate to experiment on himself, and conclusively proved to himself and colleagues the anæsthetic properties of cocaïne. He narrates the sequence of the symptoms as follows:[a]—

"When a few drops of a 2 per cent. solution are dropped into the conjunctival sac, or, better still, if they are allowed to run over the cornea, together with an increased secretion of tears, a slight burning sensation is felt, which disappears after an interval of from thirty seconds to a minute, to give way to an obscure feeling of dryness. To the observer an eye thus treated has a peculiar rigid expression, very like that which I noticed as remark-

[a] The Lancet. Vol. II., p. 990. 1884.

able in the animals upon which I experimented. This expression arises from a decided widening of the palpebral fissure, the explanation of which I shall give later. If now the head of a pin is brought into contact with the cornea we note the absence not only of the pain usually associated, but we absolutely do not feel the contact, and all reflexes are absent. The same holds good for the conjunctiva, which loses its sensibility to heat and cold. Without any inconvenient sensation, or the slightest reflex movement on the part of the patient thus treated, we can grip the conjunctiva of the bulb with a toothed forceps, or we can pit the cornea by pressure. In this connection the only thing to be observed is that the appearance of objects becomes indistinct, which naturally is caused by the changed curvature of the cornea. This complete anæsthesia lasts from seven to ten minutes, to give way to the normal condition after a considerable period of subnormal sensibility. From fifteen to twenty minutes after the instillation the pupil begins to dilate; the dilatation reaches its maximum during the first hour, decreases decidedly in the second hour, and disappears completely in a few hours more. The dilatation is never a maximal one, and during the whole time the pupil reacts promptly to light and on convergence. Therefore the feeling of dazzlement, which is connected with atropia-mydriasis, is either entirely wanting or is present to a slight degree only. With mydriasis there appears and disappears a very slight paresis of accommodation; the near point of myself and one other person I examined for this purpose was lengthened half an inch. I have observed in the normal conjunctiva, especially in the conjunctiva palpebrarum, a decided ischæmia, about the duration of which I can say nothing certain. . . . As for the previously-mentioned widening of the palpebral fissure, the symptom precedes in point of time, at any rate, its action on the iris and ciliary muscles, and as it appears almost simultaneously

with the anæsthesia of the cornea and conjunctiva, I have referred it to the anæsthesia as a cause, and explained it by the disappearance of the irritations which normally affect the cornea and conjunctiva, and cause the usual width of the palpebral fissure."

Dr. Koller then brings the same practical and important points forward :[a]—

"1. The anæsthetic effects of cocaïne can be increased to a certain limit—that is, if cocaïne be dropped into the eye after the partial cessation of the anæsthesia, a second complete anæsthesia results which lasts longer than the first. In this way I have produced complete anæsthesia, lasting from fifteen to twenty minutes, from the last application, by a continuous repetition of the application at intervals of five minutes.

"2. The anæsthetic effect is pre-eminently a local one—*i.e.*, it is stronger on those places to which the solution has been directly applied and where it has been for some time in contact.

"3. Since, as may be proved, cocaïne is absorbed, and after every instillation a quantity, even though small, reaches the anterior chamber, one would *à priori* expect that the deeper portions of the eye could be rendered anæsthetic were it possible to introduce larger quantities of cocaïne into it. But as, on the one hand, a certain time is necessary for its absorption, and, on the other, the anæsthetic effect in point of time is limited, the anæsthesia of the cornea when the iris and ciliary body began to be effected, it would therefore be necessary to anæsthetise the cornea again. I believe I can meet both of these conditions, as the following will show. By means of a continuous application repeated every five minutes with a 5 per cent. solution kept up for some time (about half an hour), I succeeded in producing such an effect on the

[a] Ut supra.

deeper parts of the bulb that its sensibility to strong pressure was very decidedly diminished."

Cocaïne ($C_{17}H_{21}NO_4$) is obtained from the Erythroxylon Coca, N. O. Linaceæ.[a] The plant usually attains the height of six or eight feet, and resembles the blackthorn in its small white flowers and bright green leaves. The natives of Peru and of the neighbouring provinces, at least in the hot moist regions, cultivate the shrub.[b] The original home of the species in America is not yet clearly ascertained. Gosse has shown that early authors, such as Joseph de Jussieu, Lamarck, and Cavanilles, had seen only cultivated specimens. An attempt is being made to cultivate the plant in India.

The name Coca[c] is derived from the Aymara (Indian) word *khoka*, signifying "plant."

And it is probably this derivation that caused Sir Robert Christison's suggestion of spelling the word Cuca to be rejected, though it so closely corresponded to the Spanish way of spelling the word.

On the arrival of the Spanish in Peru the plant was found to be held in high esteem, and its narcotic properties were well known. Poeppig[d] expatiates on the injurious effects of the coca leaf as used by the natives; and W. H. Prescott[e] thus describes the mode of preparation and the use of the coca leaf:—"The leaves when gathered are dried in the sun, and, being mixed with a little lime, form a preparation for chewing, much like the betel leaf of the East. With a small quantity of this cuca in his pouch and a handful of roasted maize, the Peruvian Indian of our time

[a] Chemistry of Common Life. Johnson and Church.

[b] Origin of Cultivated Plants. De Candolle.

[c] The Chemistry of Common Life. Johnson and Church.

[d] F. Quarterly Review. No. XXXIII.

[e] History of the Conquest of Peru. P. 60.

performs his wearisome journeys, day after day, without fatigue, or at least without complaint. Even food the most invigorating is less grateful to him than his loved narcotic."

During the reign of Tupac Inca Yupanqui, the most renowned of the "Children of the Sun," and in that of his warlike son and successor, Huayna Capac, during whose reign Vasco Nunez de Balboa, from a "peak of Darien," first took possession of the new ocean and the new continent in the names of Ferdinand and Isabella, and even to the time of the overthrow of the tyrannical Atahuallpa, the plant was reserved for the use of the Incas, the "cocals," or coca plantations, being owned by the State, and its use did not become general until Pizarro had overrun the country.

Their addiction to the narcotic is shown by the permission to use it during religious services, and even during the worship of *Pachacamac*, "he who sustains or gives life to the universe," the Chief Priest, or Villac Vmu, chewed his coca leaf; and, according to von Tschudi, unless they were supplied with it the favour of the gods would not be obtained. The suppliant for favour should approach with the coca ball, *acullico*, in his mouth, and no business without the benediction of the leaf was believed could prosper; and finally, divine rites were paid to the shrub.

When used for some time, a coca habit, as strong as and similar to an opium habit, results, and the unfortunate victim to the habit, *coquero*, becomes a pitiable object. Its first effect is to weaken digestion. To loss of appetite succeeds an inordinate desire for animal food. Then dropsical swellings and boils come on; the breath is fœtid, the lips pale, and the teeth are discoloured; the eyes are dim and sunken, and the skin becomes of a yellow tinge.

The early travellers were full of stories of the strength-giving

qualities of the plant, and Mr. Martindale[a] gives some interesting notices from Pedro de Cieza de Leon, Nicholas Monardes, Augostin de Zarate, and Joseph Acosta.

Clusius,[b] writing in 1605, says that when he asked the Indians why they always had the coca in their mouths, the answer was that when using it neither hunger nor thirst annoyed them, while their strength and vigour were confirmed. Johnson[c] considers that the least we can concede to the plant is that it enables the body to feed upon itself, so to speak, without feeling the hunger pains—a fact that may be ascribed to its anæsthetic effect on the mucous lining of the stomach, which is probably due solely to the presence of the alkaloid cocaïne.

Besides cocaïne the plant contains *hygrine*—a thick, oily liquid, with an alkaline reaction and a biting taste. It was discovered by Lossen, in 1862, but has no known therapeutic value.

The following graphic account of the action of cocaïne, in medium and full physiological doses, is that of Anrep and Rossbach's[d] experiments, taken from "Nothnagel and Rossbach's Therapeutics":—"After injecting a moderate dose (0·01 gm. per kilo) into a quiet and tractable dog, his manner became almost immediately changed. He did not remain quiet a moment, but danced in a circle round about his master on his hind legs, with his body erect and the forelegs stretched out. All his muscles were in constant motion, the tail wagging, the chest and abdomen trembling; not with convulsions, but exactly as if he were under the influence of sudden and most intense joy—by the return, say, of his master after a long absence. His expression and actions were only those

[a] Coca, Cocaïn, and its Salts. 1886.

[b] Chemistry of Common Life.

[c] Ut supra.

[d] Reference Handbook of the Medical Sciences.

of pleasure. There was not the slightest appearance of distress. This condition lasted for hours, during which he was not quiet one second while he was left free. If the hand was laid on his head or back he was able voluntarily to keep quiet, and only his hurried respiration betrayed his excitement. After from one to three hours he gradually became quiet, without any appearance of exhaustion, and continued fresh and lively.

"If the dose were increased to $1\frac{1}{2}$ centigrams per kilo (0·015 per 1,000) the excitement was intensified and distressing. He did not recognise his master, his expression was altered, he whined, barked, and trembled. He was frightened at every noise, carried the tail between the legs, wagged his head like a pendulum, and stood for fifteen minutes keeping up this rhythmical oscillation, with hurried breathing, dilated pupils, and a dry mouth. This state was suddenly succeeded by one of intense and reckless joyousness, lasting another quarter of an hour. Then he jumped unceasingly about one of the experimenters in a circle, as if bewitched. It was very difficult to call him away, not because he could not hear his master's voice, or did not wish to obey him, but because he could not resist the impulse which restrained him where he was. At last, after persistent calling, the dog appeared to throw off this spell, and rushed with great joyousness to his master, only to begin again his antics around him as he had previously done around the first observer. After three or four hours he became, as in the first instance, gradually quieter, slept, and recovered.

"After a dose of 2 centigrams per kilo (0·02 per 1,000), there was a tremendous excitement of the musculatory apparatus and the cerebrum, but soon followed by great weakness. He could not stand, but lay on the side, with the limbs drawn up, and had difficulty of breathing. Consciousness was still present. When

called he raised his head and looked entreatingly at the speaker. After twenty minutes clonic convulsions occurred, with swimming movements of the hind feet; occasionally opisthotonos. These manifestations became more severe in character; consciousness was lost; the head was constantly beaten upon the ground, and during an hour he was not quiet for a minute. Then spells of quiet appeared, which became longer and longer, and were followed by sleepiness, loss of appetite, and recovery."

Schmiedeberg[a] says that, like veratrine, it acts on the terminations of the sensory nerves; but, unlike it, it does not cause any stimulation, but induces numbness from the first. It produces a "superficial anæsthesia," while the sensory fibres remain intact. "The sensitiveness to pain is not, however, removed in cases of deep wounds, on account of its purely superficial action; the sensitiveness to reflex action is toned down, and for this reason all superficial operations can be executed, if cocaïne has been applied beforehand, without the usual painful sensations being felt by the patient."

When given in considerable doses it acts on the central nervous system. In mankind it accelerates the pulse and respiration, and induces giddiness, discomfort in the head, dilatation of the pupil, and hallucinations. In animals death results apparently because of paralysis of respiration.

[a] Elements of Pharmacology. By Oswald Schmiedeberg. Trans. by Dr. Thomas Dixson, Sydney, N. S. W. 1887.

CHAPTER IX.

Cocaine continued—Fatalities from Cocaine—Objections to the Use of Cocaine.

The use of the new anæsthetic became universal. Dr. H. D. Noyes introduced it to his American brethren through the *New York Medical Record* of October 11th, 1884. A short notice of the case appeared from Dr. Beer, of Vienna, in the *Lancet* of the 4th of October, 1884, and in the issue for the 22nd of November Dr. Prosser James recommends it as an anæsthetic for "depriving the fauces of sensibility."

At a meeting of the Ophthalmological Society of the United Kingdom, on the 11th of December, 1884, Mr. Arthur Benson,[a] of this city, brought forward a paper on the action of hydrochlorate of cocaïne on the eye, in which he stated that he had, under its influence, removed an aural polypus. "He was certain that the drug, when used pure and in abundance, would prove one of the most valuable (anæsthetics) ever discovered;" and in the April number of the same journal for 1885 Dr. Walter Smith's article on cocaïne tells how rapidly the anæsthetic had found favour with the profession.

In all painful conditions of mucous surfaces, and for minor operations, cocaïne quickly became the favourite anæsthetic. Nothing surgical seemed beyond its proper domain. J. Grossat (*Comptes Rendus*, XCIX.) recommended hypodermic injections of the hydrochlorate for anæsthetic purposes in general surgery. Even for hydrophobia it has been recommended as a remedy by Dr. Keegan (*Les Nov. Rem.*), who reports that he has successfully

[a] Dublin Journal of the Medical Sciences. Vol. LXXIX., p. 81. January, 1885.

treated the disease by painting the fauces and pharynx with a 4 per cent solution of cocaïne. Breasts were ablated under its influence, and it has been used successfully in a case of amputation of the thigh, and also in the operation for a strangulated hernia. Such a valuable anæsthetic soon found more claimants than one for its introduction, and the following article from the Paris correspondent of the *Lancet* (Jan. 3rd, 1885) is of interest:—"All (the credit) that can be accorded to him (Dr. K. Koller) (and that is a good deal) is his being the first who applied cocaïne to ophthalmic practice, for its anæsthetic properties had long been known. Other writers, in giving the history of coca and its derivatives, and of their therapeutical applications, have entirely ignored what has been done in France with these drugs. Dr. Charles Hauvel, the celebrated laryngologist of Paris, has, to my own knowledge, employed a concentrated extract of coca since 1869 at his clinique as a local anæsthetic in vaso-pharyngo-laryngeal affections. In 1877 Dr. Scoglia, Dr. Hauvel's chef de clinique, published a report in the *Gazette des Hôpitaux*, in which the anæsthetic property of coca, and its efficacy in painful affections of the throat, was brought under the notice of the profession. In 1875 Dr. Coupard, another of Dr. Hauvel's chefs de clinique, published in the *Tribune Médicale* a report entitled 'La Coca dans les Affections douloureuses du Pharynx et du Larynx,' in which a strong alcoholic extract from the leaves of the coca is stated to have been employed for painting the throat. In 1880 Dr. Coupard, in conjunction with Dr. Boodereau, undertook a series of experiments with hydrochlorate of cocaïne, which was obtained from the plant under their immediate supervision, at which the local anæsthetic and mydriatic effects were clearly established; but, for some unaccountable reason, this discovery did not receive further attention, either in this country or elsewhere, until the announcement made by Dr. Koller

at the Ophthalmological Congress held at Heidelberg in September last. The experiments of Dr. Coupard were repeated, and verified in 1882 by Dr. Labordt, the well-known experimental physiologist, who, in addition, proved that cocaïne possessed general anæsthetic properties."

In time the unfailing report came that cases had occurred in practice in which cocaïne produced alarming symptoms. Dr. Emmet Holt (*New York Medical Journal*, October 23rd, 1886) told of several cases of restlessness and convulsive movements following the application of a 4 per cent. solution of the hydrochlorate for rheumatism.

A series of cases were published in the *Medical Press and Circular*, in which unpleasant effects resulted from its use: Dr. Nicholson's two cases, in which gangrene followed the operation of circumcision; Dr. Samuel J. Earles' case (*Maryland Med. Journal*), where tetanic convulsions and loss of consciousness followed its use for hæmorrhoids; and the case of Dr. J. H. Way (*Medical News*), in which the injection of a quarter of a grain of the alkaloid produced a fall in his respirations until they only equalled nine in the minute, and an increase in the rapidity of his pulse until it reached two hundred.

On the 8th of November, 1887, Dr. J. B. Mattison, of Brooklyn, read before the American Association for the Cure of Inebriates "A Paper on Cocaïne Toxæmia," in which he records some thirty cases of cocaïne poisoning, and arrives at the following conclusions:—There is a lethal dose of cocaïne; this dose is uncertain; toxic effects are not rare. The following highly instructive case of cocaïne toxæmia is reported in Wright's *Medical Annual* for 1887. The case occurred in the practice of Dr. G. Bock, who administered a hypodermic injection of six drops of a 20 per cent. solution between the gum and alveolus previous to a dental operation. The patient was a strong woman, twenty-eight years

of age. In five minutes the woman presented the appearance of an approaching fainting fit. She answered all questions distinctly, but in another five minutes complained of not being able to see. The sensory nerves then became generally affected. Yet the pupils were normal; there was no particular pallor or cold perspiration; the conjunctiva reacted to irritation; the breathing was regular; the pulse full and strong, at between eighty and ninety. She lay as one asleep, but with open staring eyes, and talking as in delirium. Strong coffee was given her. The upper extremities were relaxed, as in chloroform narcosis; the lower extremities were tightly pressed against the operating chair. Smelling salts and sprinkling with cold water had no effect; nor did two injections of ether alter her condition. Two medical men who were consulted agreed that anæmia of the brain had resulted from contraction of the vessels. Examination of the eye with the ophthalmoscope showed that the veins were normally full, the arteries rather thinner and paler than natural, and the papilla of the optic nerve of the normal fulness. The inhalation of three drops of nitrite of amyl brought colour into the face in a few minutes; and in six minutes, another three drops having been inhaled, there was a considerable flushing of the face and return of consciousness. A good night's sleep followed, and the woman was in perfect health next day.

In the *Lancet* for the 21st of November, 1885, Dr. F. de St. Hall records a case of laryngeal spasm caused by cocaïn spray (10 per cent. solution) in a patient, fifty-six years of age, who was suffering from asthma. The administration of chloroform vapour overcame the spasm, but it was not until four hours after the attack that the patient had quite recovered from the shock.

In the case of accidental poisoning of a male adult patient, aged thirty, by a dose of twenty grains of the alkaloid in the University

College Hospital, death, which was preceded by "some arching of the back resembling the opisthotonos of tetanus," and some convulsive movements of the limbs, occurred in an hour's time. Consciousness was retained almost up to the end. The *post-mortem* examination revealed congestion of the lungs, brain, and mucous membrane of the stomach.[a] The deceased had suffered from tuberculosis of the lung, and the left kidney had been almost entirely destroyed. Unfortunately the initial symptoms were not observed. The kidney disease had so crippled the eliminative power of the deceased that he succumbed to the dose,[b] "although in one case twenty-three grains and a half were swallowed without fatal results." In the same journal Mr. Henry Ashworth gives a case of unusual and alarming effects following from the subcutaneous injection of one grain of the alkaloid in "a middle-aged man, and fairly well nourished, who was admitted (to the Halstead Cottage Hospital) for recurrent cancer of the upper lip."

Even small doses have been known to produce toxic effects in healthy individuals. Mowat[c] relates the case of a man, aged twenty-nine, in whom the injection of one-seventh of a grain caused coldness of the extremities, pallor, and difficult respiration. Numerous cases of cocaïne toxæmia are to be found in current medical literature, as a reference to Neale's Digest (First Appendix) will show.

That cocaïne does not fulfil all the expectations of its early eulogists is indubitable. Dangers attend its use, as they do that of all active drugs; but more than that, its physiological effects are not such as to warrant the unstinted praise so freely bestowed on

[a] Medical Press and Circular. Feb. 6th. Lancet. Feb. 9th. British Medical Journal. Feb. 9th, 1889.

[b] Lancet. February 9th, 1889.

[c] British Medical Journal. February 9th, 1889.

it a few years since. Its anæsthetic action is too local to make it of any service in other than superficial operations. From my own experience of it I found that the hypodermic injection did not produce anæsthesia of the deeper tissue, so that whilst the skin-cut was painless the sensibility of the subcutaneous and muscular tissues was little, if at all, affected.[a]

The alkaloid is also said to interfere with the healing process when used hypodermically. Professor Frey,[b] of Vienna, found that after an operation made under the influence of cocaïne anæsthesia, though it was "duly treated with antiseptics, no union *per primam intentionem* took place, as the margins of the incised wound had become necrotic and fallen off owing to a suppurating process. This condition could be explained only by the suggestion that owing to the influence of cocaïne on the vaso-constrictors a complete stagnation of the circulation was caused."

Even in ophthalmic surgery it has not fully met all the requirements of the profession. In a communication to the Paris Academy M. Javal[c] stated that the instillation of a solution of cocaïne increased the tension of glaucomatous eyes; and at a meeting of the Ophthalmological Society on the 12th of November, 1885, Messrs. Nettleship, M'Hardy, Brown, and Lang[d] stated that they suspected cocaïne as the cause of an epidemic of panophthalmitis which was then prevalent. Mr. Nettleship also stated that he had found interstitial keratitis much more common since he had used the drug. Dr. Dudley Buxton[e] points out that for operations on the cornea cocaïne is not free from disadvantages.

"Excision of the eye in most cases in which cocaïne was used

[a] Medical Press and Circular. Vol. II. 1888.
[b] Medical Press and Circular. September 7th, 1887.
[c] Medical Press and Circular. 12th May, 1886.
[d] Lancet. 28th Nov., 1885.
[e] Anæsthetics. By Dudley Wilmot Buxton, M.D. P. 138.

proved painful—at all events during the last stages, when the deep structures were divided."[a]

On its use in dental practice Mr. C. E. Truman[b] contributes a valuable article, in which he gives a short summary of each case. In the first case, a girl aged fourteen, the patient fainted after the operation; the sixth case, a man aged nineteen, also fainted; the eighth, a woman aged twenty-five, felt pain during the tooth extraction; the ninth case, a girl aged sixteen, results unsatisfactory; eleventh case, partial anæsthesia; thirteenth case, a boy aged fourteen, result unsatisfactory; sixteenth case, a woman aged thirty, "complained of feeling sick and faint, and seemed rather bewildered."

Dr. R. Wood[c] records, in the *Australasian Medical Gazette*, alarming symptoms of poisoning following a dose of four drops of a 20 per cent. solution of cocaïne given for dental neuralgia. "Cramps, and rigidity of fingers, arms, and legs, with a tendency to opisthotonos," were observed.

Heymann[d] produced cocaïne toxæmia by brushing the fauces and larynx of a boy, nine and a half years old, with 5 grm. of a 20 per cent. solution. "The operation was scarcely finished when the boy began to reel off the seat, and when removed to a sofa lay in an apathetic somnolent condition for about five hours."

Of its use in the minor operations in general surgery Russian surgeons speak favourably. Dr. J. J. Minkiewicz,[e] of Tiflis, reports (Proceedings of the Caucasian Medical Society) that under the anæsthesia produced by the hypodermic injection of cocaïne, he excised subcutaneous atheroma, lipoma, extracted bullets, and

[a] Handbook of Therapeutics. Ringer. Twelfth Edition. P. 533.
[b] St. Thomas's Hospital Reports. N. S. Vol. XV., p. 93.
[c] Dublin Journal of Medical Science. Vol. LXXXII., p. 508. December, 1887.
[d] Dublin Journal of Medical Science. Vol. LXXXIII., p. 150. February, 1887.
[e] London Medical Record. Vol. XV., p. 145.

soforth. Strange to say, he did not find it so useful in tonsillotomy. Dr. Tchernomordik[a] (*Vratch Mot.*, 1887) gives a record of twelve operative cases, some of which were of considerable importance, as successfully anæsthetised by hypodermic solutions of cocaïne.

As an anæsthetic for operations on the urethra cocaïne became largely used, but that in these cases there also is danger is shown by Dr. J. C. Sims' case, in the Episcopal Hospital, Philadelphia, in which death resulted after the injection of one drachm of a 20 per cent. solution of the muriate. "The instrument was scarcely taken out of the urethra when the patient made a foolish remark, the muscles of his face began to twitch, the eyes staring, pupils dilated, frothing at the mouth, face congested, respiration interfered with, and ending in a violent epileptiform convulsion, lasting for some seconds. These convulsions were continued, with increasing violence, several times a minute, the whole muscular system taking part in the spasms, requiring considerable force to keep him from falling off the table." At the end of twenty minutes from the first convulsion the man was dead.[b]

The physiological action of the alkaloid is, according to Dr. T. Lauder Brunton,[c] "due to stimulation of the peripheral ends of the sympathetic." In its action on the nervous system "it affects first the cerebral hemisphere, next the medulla, and afterwards the spinal cord. . . . The convulsions are of cerebral origin, and cease when the spinal cord is divided. The motor columns of the spinal cord appear to be unaffected, but the sensory are paralysed. In its action on respiration and circulation, cocaïne, to a certain extent, resembles atropine, and it does so also in its action on the pupils, intestinal movements, and salivary and sweat glands. The

[a] Ut supra.

[b] Phil. Med. News, July 21, p. 71, and Braithwaite's Retrospect of Medicine Vol. XCVIII., p. 66.

[c] Pharmacology, Therapeutics, and Materia Medica. Third Edition. 1887.

respiration is greatly increased at first, afterwards diminished, and death occurs from respiratory paralysis. Small doses quicken the pulse and raise the blood-pressure; large doses slow the pulse and lower the blood-pressure. The quickness of the pulse appears to be due to paralysis of the vagus. . . . The temperature is generally raised."

Elimination of the drug by the kidneys is often accompanied by the production of albumen and sugar in the urine. Von Anrep regards these as resulting from the asphyxia caused by the cocaine's paralysing action on the respiratory muscles, and not from any direct action of the alkaloid[a] (Buxton).

Aqueous solutions of the salts of cocaïne are liable to undergo decomposition by the growth of a fungus; the addition of salicylic, boric, and carbolic acids, and also of chloroform have been recommended to prevent the deleterious fungoid; but as yet no satisfactory results have been obtained. Many of the unpleasant effects of the alkaloid are ascribed to the presence of the fungus.

As an antidote in cases of cocaïne poisoning, nitrite of amyl has been recommended. It dilates the peripheral vessels. To prevent death from respiratory tetanus, Mosso, as the result of numerous experiments, recommends the inhalation of ether or chloroform. Chloral hydrate which antagonises all the actions of cocaïne poisoning, except the rise of temperature, has not been of much service in actual cases of poisoning, and the same statement applies to morphine, which is a physiological antidote to cocaïne.

[a] Handbook of Therapeutics. Twelfth Edition.

CHAPTER X.

Royal Medico-Chirurgical Society's Committee of Inquiry—Their Report on Chloroform of A.D. 1864—Rules in same relating to the Administration of Chloroform—A. C. E. Mixture—Anæsthetic Statistics of St. Bartholomew's Hospital, London.

THE many deaths occurring during the administration of anæsthetics caused the Royal Medico-Chirurgical Society to appoint a Committee "To inquire into the Uses and the Physiological, Therapeutical, and Toxical Effect of Chloroform, as well as into the best mode of administering it, and of obviating any ill consequences resulting from its administration." The members were—J. B. Curling (Chairman), Thomas Bryant, Samuel Cartwright, Arthur Farre, George G. Gascoyen, George Harley, Prescott Hewett, F. W. Mackenzie, William Marcet, Charles H. Moore, James Paget, William O. Priestley, Richard Quain, Francis Sibson, R. Dundas Thompson, Charles West; Septimus W. Sibley, George W. Callender, Reporters; John Birkett, Hon. Secretary.

"Mr. Clover, though not a member of the Committee, attended, at their request, nearly all the meetings for experiments, administered the chloroform, and continued to employ, from time to time, with remarkable ingenuity, special apparatus for carrying them on."[a]

The Committee collected a great number of facts, and made many valuable suggestions for the guidance of anæsthetists. The Report was presented on the 14th of June, 1864, and it was read on the 5th of the following July. It occupies one hundred pages

[a] Transactions, Medico Chirurgical Soc., Vol. XXIII.

of the Transactions for that year, and as the suggestions are, after a lapse of twenty-five years, little known to the younger members of the profession, they bear re-telling:—

"RULES RELATING TO THE ADMINISTRATION OF CHLOROFORM.

"Chloroform should on no account be given carelessly, or by the inexperienced; and when complete insensibility is desired, the attention of its administrator should be exclusively confined to the duty he has undertaken.

"Under no circumstances is it desirable for a person to give chloroform by himself.

"It is not advisable to give an anæsthetic after a long fast, or soon after a meal, the best time for its administration being three or four hours after food has been taken.

"If the patient is much depressed there is no objection to his taking a small quantity of brandy, wine, or ammonia, before commencing the inhalation.

"Provision for the free admission of air during the patient's narcotism is absolutely necessary.

"The recumbent position of the patient is preferable, the prone position is inconvenient to the administrator, but entails no extra danger. In the erect or sitting posture there is no danger from syncope. Sudden elevation or turning of the body should be avoided."

"An apparatus is not essential to safety if due care be taken in giving the anæsthetic. Free admixture of air with the anæsthetic is of the first importance, and, guaranteeing this, any apparatus may be employed.

"If lint, or a handkerchief, or a napkin is used, it should be folded as an open cone, or held an inch or an inch and a half from the face.

"Chloroform should invariably be given slowly; sudden increase of the anæsthetic is most dangerous. Three and a half per cent. is the average amount, and four and a half per cent., with ninety-five and a half per cent. of atmospheric air, is the maximum of the anæsthetic which can be required. Given cautiously at first, the quantity within this limit should be slowly increased according to the necessities of the case, the administrator being guided more by its effect on the patient than by the amount exhibited.

"The administrator should watch the respiration of his patient, and must keep one hand free for careful observation of the pulse.

"The pulse of the temporal artery answers all purposes as well as that of the radial, and is much more convenient for the chloroformist.

"The patient who appears likely to vomit whilst beginning to inhale the anæsthetic, must be at once brought fully under its influence, and the tendency to sickness will then cease."

"The occurrence, during the administration of an anæsthetic, of sudden pallor, or sudden lividity of the patient's countenance, or sudden failure or flickering of the pulse, or feeble or shallow respirations, indicates danger, and necessitates immediate withdrawal of the anæsthetic until such symptoms have disappeared.

"On the occurrence of these symptoms, and especially if they should become so urgent as to threaten death from failure of respiration or of heart action, or of both together, the following rules of treatment are to be observed:—Allow free access of fresh air, pull forward the tongue and clear the mouth and fauces, keep or place the patient recumbent, dash cold water on the face and chest, and aid the respiratory movements by rhythmical compression of the thorax. In the more threatening cases commence instantly with artificial respiration, whether the respiration has failed alone, or the pulse and the respiration together.

"Galvanism may be used in addition to artificial respiration, but the artificial respiration is on no account to be delayed or suspended in order that galvanism may be tried.

"Few, if any, persons are insusceptible of the influence of chloroform, from two to ten minutes being required to produce anæsthesia. The time, however, varies with age, temperament, and habits."

Of the uses of chloroform in surgical operations the Committee report that, "With heart disease the anæsthetic may be given in any case which requires an operation, although when there is evidence of a fatty, weak, or diluted heart, great caution is demanded; valvular disease is of less importance.

"In phthisis, when an operation is unavoidable, anæsthetics may be given with impunity.

"For all operations upon the jaws and teeth, the lips, cheeks, and tongue, anæsthetics may be inhaled with ordinary safety. By care and good management the patient may be kept under their influence to the completion of the operation. In all these cases blood, as it escapes, if not voided by the mouth, passes into the pharynx. If any small quantity finds its way through the larynx, it is readily expelled by coughing. In operations on the soft palate, fauces, pharynx, and posterior nares, if sudden or severe hæmorrhage is likely to occur, it is not advisable to induce deep insensibility. In cases requiring laryngotomy and tracheotomy anæsthetics may be employed with safety and advantage."

"For operations upon the eye, involving the contents of the globe, the use of anæsthetics is open to objection, on account of the damage which the eye may sustain from muscular strain or vomiting. If employed profound insensibility should be induced.

"In operations for hernia, and in the application of the taxis,

anæsthetics act most beneficially. For most operations about the anus profound anæsthesia is positively demanded.

"In the condition of shock, or of great depression, as after hæmorrhage, the careful administration of anæsthetics diminishes the risk of an operation."

They concluded that:—

"Chloroform at first increases the force of the heart's action—this effect is slight and transient.

"When complete anæsthesia is produced by chloroform, the heart in all cases acts with less than its natural force.

"The strongest doses of chloroform vapour, when admitted freely into the lungs, destroy animal life by arresting the action of the heart.

"By moderate doses of chloroform the heart's action is much weakened for some time before death ensues; respiration generally, but not invariably, ceases before the action of the heart, and death is due both to the failure of the heart's action and to that of the respiratory function.

"The danger attending the use of chloroform increases with the degree of stupor it induces.

"Apparent irregularities in the action of chloroform depend on the varying strength of the vapours employed, on the quality of the chloroform, and on the constitution of the patient."

They recommended, as preferable to either chloroform or ether, the following mixtures, to wit:—

A. Alcohol, sp. gr. 838, 1 part.
Chloroform, sp. gr. 735, 2 parts.
Ether, sp. gr. 1,497, 3 parts.
Mix.

B. Chloroform, - - 7 parts.
Ether, - - 4 parts.
Mix.

C. Chloroform, - - 1 part.
Ether, - - 2 parts.
Mix.

The first mixture, which quickly became known as the "A. C. E. mixture," was from a well-known formula of Dr. Harley's, and the formulæ B. and C. were similar to some in use in America.

The Committee arrived at the conclusion "that a mixture of ether and chloroform, such as A. or C., is as effective as pure chloroform, and a safer agent when deep and prolonged anæsthesia is to be induced, while at the same time it is sufficiently rapid in its operation to be convenient for general use."

It is a strange comment on this recommendation to find that operative surgeons still prefer to use either chloroform or ether in an undiluted state. The statistics of St. Bartholomew's Hospital for the years 1885, 1886, and 1887, show that not one of the mixtures recommended were once used during the three years, although in 1885—

Chloroform was administered	-	1,331 times
Nitrous Oxide Gas (alone)	-	378 „
Ether (alone) - - -	-	1,118 „
Ether, preceded by Nitrous Oxide Gas	-	386 „

Making a total of 3,213 cases of anæsthetic administration without a death. In 1886—

Chloroform was administered	-	1,425 times
Gas - - - -	-	385 „
Ether - - - -	-	1,109 „
Gas and Ether - - -	-	567 „

Making a total of 3,486 times. One death occurred during the administration of chloroform—the patient had a suppurating kidney, he was "seized with syncope before anæsthesia was complete, and died in a few minutes." In 1887—

Chloroform was administered	-	-	1,702	times
Gas	-	-	-	-	-	415	„
Ether	-	-	-	-	-	1,197	„
Gas and Ether	-	-	-	-	662	„

Total number, 3,976. One death, that of a man aged fifty-two, in whom the *post-mortem* presented a fatty heart. He was suffering from cellulitis of the leg.

Thus we find that in three years chloroform was administered 4,458 times out of 10,675 anæsthetic administrations in St. Bartholomew's Hospital.

CHAPTER XI.

Committee of British Medical Association of A.D. 1880—Notice of their Report—The Monatomic Fatty Alcohols—Chloroform, Ether, and Alcohol compared—Prevost's Experiment—The Four Stages in Action of Anæsthetics—Nélaton's Experiment—Its Outcome in Practice—Cases of Dr. J. J. Chisolm—Morphine and Chloroform in Combination—Claude Bernard's Experiment—Observations of Ringer and Brunton.

THE Committee appointed by the British Medical Association in December, 1880, made a report on anæsthetics, and many cases of death during the administration of anæsthetics collected by them were clearly proven to be due to either carelessness or ignorance, and in some cases both carelessness and ignorance were in evidence. The report appears in the issue of the *British Medical Journal*, for the 15th of December, 1880, and its practical outcome was—a strong condemnation of chloroform, a partial condemnation of ether, and a strong recommendation of the dichloride of ethidene—an anæsthetic which to-day is practically unknown to the profession, and which has not been once used in the ten thousand odd cases noted above.

Independent workers also were not idle, our principal home and foreign journals tell of their industry, and to them we are principally indebted for our modern views on the physiological action of anæsthetics, and the best means for avoiding danger during their use. The literature of the subject is enormous—the Index Catalogue of the Library of the Surgeon-General of the U. S. A. Army includes sixteen hundred odd newspaper articles on chloroform alone.

The compounds of the monatomic fatty alcohols—which include chloroform, ether, and alcohol—all act in the same way. Chloro-

form, however, differs from both alcohol and ether by its more paralysing influence on the heart—a property which is peculiarly well-marked in the halogen anæsthetics, and is not peculiar to chloroform. But it is peculiar to the chloroform group of anæsthetics that the respiratory centre is the last of all the parts of the central nervous system to be deprived of sensibility. Its effects on the central nervous system consist in the paralysis of the brain, spinal cord, and medulla oblongata; and the parts are affected in the order named.

The monatomic fatty alcohols differ essentially in their action from morphine, in that from the very first they lessen and finally abolish reflex action, whilst morphine increases the reflex irritability of the central nervous system, as is occasionally demonstrated by tetanus occurring in cases of opium poisoning.

It is claimed for ether that it does not exert the same influence as chloroform on the heart, neither does it lower the vascular *tonus* to the same extent.

Of chloroform it is also stated that its continued use tends to produce fatty degeneration of the heart—a statement not supported by some recent experiments which were conducted in India,[a] and one not in accord with clinical experience. Chloroform exerts a marked influence on the blood pressure, but how it lessens it to the extent it does is not exactly known; it paralyses the nervous centres for the vessels. produces dilatation, but the great dilatation is believed to be in part due to the direct action of the anæsthetic on either the muscular tissue or nerve ends in the walls of the arterioles.

Dr. Brunton quotes from *The Practitioner* Prevost's experiment, showing the influence of chloroform when directly applied to the nerve tissue, to wit:—"Chloroform applied directly to the brain of a frog narcotises it when the aorta is tied. When the aorta is

[a] Lancet, February, 1887.

again unligatured, so that the current of blood can again wash the chloroform away, the narcosis disappears."[a]

Four stages are recognised in the action of anæsthetics—the stimulant stage, the narcotic stage, the anæsthetic stage, and the paralytic stage.

The third stage is the one in which operations may be safely undertaken: during the second stage all the reflexes are not abolished, and shock from the operation is superadded to the risk of a low arterial *tonus*. In the third stage, all the reflexes being paralysed, there is no shock, and the sole risk may be said to be the low blood pressure.

Clinically the third may be distinguished from the second stage by the cessation of struggling and delirium, should either be present, and the absence of reflex on touching the palpebral and sclerotic conjunctivæ.

The fourth, or paralytic stage, is that in which the respiratory centre is paralysed, respiration ceases, and the pulse becomes very feeble.

During anæsthesia the brain becomes anæmic. Nélaton, in 1855, remarked that the brain of a rat became markedly anæmic whilst the animal was under chloroform anæsthesia, and he remarked that when in the paralytic stage, and respiration had ceased, that suspension of the animal by the tail with its head down restored respiration, and the heart resumed its normal action, whilst another rat in the condition-stage of anæsthesia, left lying on the table, died. This observation has been turned to practical account, as the following cases of Dr. Julian J. Chisolm,[b] of Baltimore, Maryland, show, who also suggests that the good result obtained may be in part due to the emptying of the blood from the great reservoir,

[a] Pharmacology. Third Edition. 1887. P. 206.

[b] Chloroform: the Best of Anæsthetics. 1888.

the liver, through the vena cava into the cavities of the heart, stimulating them into renewed activity. In Dr. Chisolm's pamphlet,[a] the following cases are selected as typical of the value of the inversion method, when the anæsthesia may unfortunately have reached the paralytic stage :—

"R. A., a robust, healthy child, three years of age, was recently brought to me with a cancerous left eye. The attention of the parents was first called to the yellow appearance of the pupil eighteen months before. The gliomatous mass filled the vitreous cavity, distending the pupil, and obliterating the anterior chamber; the left eye was injected and painful. The prompt removal of the eyeball was urged as the only means of protecting the child from a painful death. The operation was accepted by the parents, and enucleation, under chloroform, accomplished after much difficulty. . . .

"The child was suffering from a bronchial trouble, but that was not deemed an obstacle to the administration of an anæsthetic. The patient was placed on the operating table, his clothing loosened about the neck and chest, and chloroform was inhaled from a towel, folded in a conical form, with open top; deep sleep was soon induced.

"When the anæsthesia was complete, the operation for the removal of the diseased eye was commenced. The conjunctiva was divided around the cornea, and the tendon of the external rectus muscle was sought for, when respiration suddenly ceased, the face assumed a death-like pallor, the pulse disappearing at the same time from the wrist. Immediately the child was suspended by the feet, with body and head hanging down at an inclination of seventy degrees, while an assistant volunteered chest-compression

[a] A Very Valuable Lesson for those who Use Anæsthetics. A Paper read before the Baltimore Academy of Medicine, Dec. 6th, 1887.

for artificial respiration. After a few minutes, signs of a feeble respiratory movement was noticed, a slight throbbing of the neck-vessels was detected, and in time the child evinced its return to consciousness by crying. He was laid on the table, but would not permit the eye to be touched without a twist of the head, evincing great irritability or sensitiveness of the conjunctiva. As the operation had to be completed, I ordered chloroform to be again administered. Chloroform narcosis was very soon re-established, but before I had time to resume the operation the child again stopped breathing, and the pulse disappeared. The body, apparently of a dead child, was once more hung up by the feet, so as to allow blood to gravitate towards the anæmic head and brain, but with no further attempts at artificial respiration. Myself and four assistants watched anxiously the pale face, to catch the first evidence of returning vitality. After some minutes I noticed that the large vessels at the root of the neck showed some fulness, then a slight thrill, and after this the first attempt at a thoracic movement appeared. In ten minutes breathing was sufficiently strong to allow the child to cry again, much to the relief of all of us.

"Still the operation which was so imperatively called for, for the future safety of the child—even the saving of its life from the ravages of cancer—was uncompleted. While the father and mother—both present in the operating room—were pleading for their child, they were made aware, by the restlessness of the patient when the eye was touched, that nothing could be done without the child going again to sleep, so I once more ordered the inhalation of chloroform. For the third time chloroform narcosis was promptly established, and was followed very soon afterwards by suspended respiration and the disappearance of the pulse. Death now seemed to be complete; immediately the child was hung up by the feet. The absolute quiet of the operating room

was broken only by the lamentations of the parents. All eyes watched the face of the child; five minutes seemed an hour, and the ashy lips showed, so far, no response. Soon after this a faint effort at respiration was observed—which became stronger with each return of the thoracic movements—and the pulse was again felt feebly at the wrist. When respiration seemed established, complete insensibility continuing, I had the child laid on the operating table. As soon as the body assumed the horizontal position, the pulse, not yet strong, disappeared from the wrist, and the respiration ceased, necessitating at once a renewal of the suspension. This curious phenomenon of breathing when suspended, and becoming inanimate when the prone position was too early assumed, was repeated two or three times respectively. For safety—for I was afraid to lay the child down—I was forced to enucleate the eye while the child was suspended with head downwards, an awkward position for operating. It was some time—fully a quarter of an hour—after the operation was completed and the eye bandaged, before I could trust the child in the recumbent position."

The second case is as follows :—

"Eighteen months since I ordered chloroform to be administered to a patient eighty years of age, who had his right ear a mass of epithelioma. . . . His history, as given by himself, was quite a curious one of coincidences. He had been married twice; his first wife had a cancer of the breast, for which an operation had been recommended by his family physician; she died under chloroform before any incisions were made. His second wife was brought to me six years ago, suffering from a malignant disease of the socket, involving the eyeball, the eyelids, and skin of cheek. . . .

"I declined to operate. . . . Against my advice, the local physicians urged the operation, and in her anxiety to get rid of the

cancer, she yielded to their solicitations. They undertook it, and she died during the operation—they said from the effects of chloroform. There was no blood relationship between himself and either of his two wives, and yet he also had a cancer for which an operation under chloroform was advised. . . . In his desire to get rid of the fœtid discharge he submitted, without hesitation, to the course recommended. First a full dose of whisky was taken, and then chloroform was administered by the resident physician of the hospital, aided by the medical staff. I had left the operating room for a few minutes to show to a medical visitor some cases of interest in the wards, when the nurse ran to inform me that the man whom I had just left was dead. . . . I found one of the physicians trying thoracic compression for artificial respiration on an apparently lifeless body lying flat on the operation table. I had this immediately stopped, and under instructions the four doctors present, with the nurse and the brother of the patient, held up the lower end of the operating table, so as to incline the body and head at an angle of over forty-five degrees. . . . In a very few minutes we had the satisfaction of seeing slight thoracic movements; then the ashy, livid face lost its death-like hue. When respiration became fully re-established the table was lowered, and the operation safely completed, no more chloroform being required in the case."

The combination of morphine and chloroform in preference to chloroform alone was once strongly advocated. Dr. Alexander Crombil,[a] Surgeon to the Calcutta Medical College Hospital from 1873, writing in 1881, says: "It has never been my misfortune to see a death from chloroform," and ascribes his success to the combined use of morphine and chloroform. He recommends an hypodermic of morphine to be given immediately before the administration of chloroform. The combined use was due to an obser-

[a] Practitioner. Vol. XXV., p. 401.

vation of Claude Bernard's.[a] He had occasion to administer a dose of morphine to a dog recovering from the effects of chloroform, and he was surprised to find that the morphine reproduced the anæsthetic effects of the previous dose of chloroform. More recently this experiment was modified, so that a dog narcotised by morphine was completely and quickly anæsthetised by a quantity of chloroform very much smaller than would have been necessary to have produced this effect in a dog in a normal condition. Bernard believes that this can be explained only by supposing that the action of one substance superimposed on that of the other. Morphine, by blunting the nervous sensibility, aids the action of the chloroform, and thus a quantity of the latter, in itself insufficient to produce complete anæsthesia, becomes sufficient to do so when assisted by morphine. The practice, however, fell into disrepute, and is rarely resorted to at present.

The most frequent cause of death from chloroform is incomplete anæsthesia.

A very valuable article by Dr. Sydney Ringer[b] shows how little capable of supporting shock the heart is during anæsthesia:—"When under chloroform a heart is greatly weakened, almost to the point of arrest." Of the different effects of ether and chloroform on the heart he thus expresses himself:[c]—"One or two minims of chloroform rapidly weakens and arrests the ventricle, even fifty minims of anhydrous ether merely accelerates the beats and weakens them a little. Chloroform arrests the heart in diastole."

The danger of imperfect anæsthesia is thus graphically described by Dr. Lauder Brunton:[d]—"A very large proportion of the deaths

[a] Revue des Cours Scientifique, and Bulletin Général Thérapeutique, 30th Sept., 1869, p. 241. Journal of Anatomy and Physiology. Vol. IV., p. 166.

[b] Practitioner. Vol. XXVI., p. 40.

[c] Practitioner. Vol. XXVII., p. 16.

[d] Pharmacology. 3rd Edition. 1887.

from chloroform occur during the extraction of teeth, and we may take this action as a typical one in regard to the mode of action, both of the sensory irritation and of the chloroform. When a tooth is extracted in a waking person, the irritation of the sensory nerve produced by the operation has two effects—1st, it may, acting reflexly through the vagus, cause stoppage of the heart and a consequent tendency to syncope; 2nd, it causes reflex contraction of the arterioles, which tends to raise the blood-pressure, and counteract any tendency to syncope which the action of the vagus might have produced.

"In complete anæsthesia all these reflexes are paralysed, and thus irritation of the sensory nerves by the extraction of the teeth has no effect either upon the vagus or the arterioles. In imperfect anæsthesia, however, the reflex centres for the arterioles may be paralysed, while the vagus centre is still unaffected."

Next in frequency as a cause of death during anæsthesia, is the administration of too concentrated a vapour. Great quantities of chloroform enter the blood, and get into the left side of the heart, the latter suddenly ceases to act, and death results before deep narcosis has been reached. Happily this accident is becoming more rare. It has been my lot to see such a case occur, but with our present knowledge of the action of the anæsthetic the accident should never occur, and is easily avoided.

"In giving chloroform care must always be taken that the *vapour* be inhaled only after being sufficiently *diluted with air*, so that the chloroform passes the left side of the heart in small quantities, and finds time to diffuse itself uniformly in the body."[a]

[a] Schmiedeberg's Elements of Pharmacology. 1887. P. 30.

CHAPTER XII.

Prolonged Chloroform Anæsthesia—Untoward Results from Chloroform—Chloroform with Oxygen—Dosage Difficulties—Chloroform in Cardiac Diseases—Report of the Hyderabad Commission—Experience of Drs. Lawrie, M'Guire, Chisolm, Buxton, Hewitt, Reeves, and White—Cases in which Ether is unsuitable—Statistics.

CHLOROFORM anæsthesia may, if proper precautions are taken, be prolonged for some hours. In a case of ilio-femoral aneurysm in St. Vincent's Hospital, under the care of Dr. Mapother, the anæsthesia was kept up for twelve hours. He writes,[a] "I determined to postpone deligation, and employ compression with the aid of chloroform. Next morning (Monday, 27th February), at eight o'clock, I chloroformised the patient, and at once stopped all pulsation by pressure with Carte's apparatus, in the common iliac artery, about one inch below the umbilicus, and half an inch to its right side. The skin was shaved, and protected by finely-powdered French chalk. The stoppage in the circulation was never complete for more than a few minutes, for the movements of the patient, the action of the abdominal muscles, the rolling of the vessel under the pad, allowed an occasional slight current to pass through it. Severe vomiting occurred at seven p.m., and rigors succeeded every fifteen or twenty minutes, and for these reasons the administration of chloroform was discontinued at eight p.m., having been maintained for twelve hours; and the patient at once feeling pressure intolerable, the instrument was removed. . . .

"On Saturday, March 4th, as my patient had considerably recovered his strength, I resolved to try pressure with the help of

[a] Medical Press, 29th of March, 1865.

chloroform once more, and as the red and exquisitely tender patch produced by the former attempt reached the umbilicus, the aorta seemed the only available vessel. . . . The patient having been rendered quite anæsthetic, the superficial femoral, according to Dr. O'Ferrall's suggestion, was compressed by Skey's tourniquet just below the sac, in which most of the blood was in this way retained. The horse-shoe clamp, Signorini's . . . was placed one inch above the umbilicus. . . . When the screw at the junction of the arms was turned to its utmost, all pulsation in the tumour and the opposite limb stopped. From nine a.m. till half past eleven the pulsation occasionally recurred by the patient moving, which shifted the clamp towards the right side. At that hour, with the assistance of Mr. Collis, . . . it was tied over to the left side by a bandage wound round its pads. When thus adjusted it was found that the left femoral pulsated, indicating that pressure was now on the common iliac. However, as the pad was one inch above the umbilicus, the aorta must have bifurcated one and a half inches higher up than usual. For four and a half hours uninterrupted pressure was maintained, and on removing the instrument on the termination of that period we were indeed overjoyed to find the tumour solid and entirely pulseless. He had two severe rigors, which we relieved with brandy and external warmth."

Dr. Murray,[a] Lecturer on Physiology in the University of Durham, kept a patient under the influence of chloroform for five hours without any unpleasant result. Mr. Heath,[b] of the Newcastle Infirmary, in a case of aneurysm of the external iliac, maintained chloroform anæsthesia for seven hours. Long-continued inhalations of chloroform, however, occasionally produce unpleasant effects.[c]

[a] Ut supra.

[b] Ut supra.

[c] The London Medical Record. Vol. XII., p. 69.

The *Journ. de Méd. et Chir. Prat.*, 1883, reports the case of a young woman, who was seized with violent headache a fortnight after her confinement. The pain yielded only to chloroform inhalations, which were continued during three days; after that time the patient became restless, tried to escape, and was beset during ten days with terrible hallucinations. A man who was suffering from neuralgia, and who had been under the influence of chloroform for about twelve days, was seized with similar symptoms, which lasted nearly two weeks.

Purpura has been caused by its inhalation. Morel Lavalée[a] reports (*Journ. de Méd. et Chir. Prat.*) three cases, in which an abundant eruption of purpura rapidly developed in patients who had just began to inhale chloroform. After two or three minutes the anterior surface of the thorax was covered with patches measuring three or four millimetres in diameter; some of them were rapidly transformed into bullæ, filled with bloody fluid. These purpuric patches are probably caused by some reflex angiectasis, and seem to belong to the same class as the nervous purpura, which, according to Vidal and Fournier, has been seen to occur after a violent emotion.

One of the most annoying results from anæsthesia is the production of erotic hallucinations, which occur during recovery from the narcosis; and, as is the rule in subjective impressions, they are very vivid. This danger, if there were none other, would be sufficient to necessitate the presence of a second medical man during the administration of an anæsthetic.

Of the many suggestions made to diminish the risk of chloroform narcosis, one of the most recent is that known as Neudörfer's method, of which Dr. V. Idelson[b] gives the following account

[a] The London Medical Record. Vol. XII., p. 164.

[b] The London Medical Record. Vol. XIII., p. 514.

(*Vratch*):—"At a meeting of the St. Petersburg Medical Society, Dr. Beitels made a communication on artificial anæsthesia after Neudörfer's method, somewhat modified by himself. Anæsthesia, by means of a mixture of chloroform with oxygen, requires far less quantities of chloroform comparatively with the usual methods of its administration, and is, accordingly, associated with less danger. Moreover, perfect anæsthesia ensues far more easily, and may be obtained even in those patients in whom chloroform alone has failed. When the quantity of chloroform in the mixture does not exceed 10 per cent., no sickness is observed. The pulse remains unchanged, the tongue never falls back. To ensure complete narcosis, it is essential to firmly adjust the mask to the patient's face. Professors A. J. Krassovski and V. V. Sutugin have also obtained good results from the use of a mixture of chloroform with oxygen."

The difficulty of regulating the proper proportions of chloroform vapour and oxygen interfered with the general acceptance of the mixture, although Professor Neudörfer, in his practice in Vienna, demonstrated that it produced speedy insensibility without excitement, and was free of the dangers incident to the use of chloroform. Dr. Kreutzmann, of San Francisco, Ca., however, devised a more simple arrangement for the administration of the chloroform vapour and oxygen gas than that used by Neudörfer, and published his results in the *Centralb. für Chir.*, No. 35, 1887. His paper is made the subject of an article by Dr. Johnson Smith,[a] who writes: "Kreutzmann has given up all endeavour to supply the chloroform in fixed doses according to Neudörfer's directions, and now, in order to administer the mixture in an efficient manner, he attaches, with the intervention of an exhausting pump, an elastic bag containing oxygen to Junker's chloroform apparatus. In this way

[a] The London Medical Record. Vol. XV., p. 441.

oxygen in the place of atmospheric air is pumped through the chloroform, and the patient inhales oxygen impregnated with chloroform vapour. It is pointed out that some air is taken in at the same time, as it is impossible to exclude this by the mouth-piece."

Dr. Kreutzmann speaks very favourably of the results obtained from the use of this mixture in twenty-three operations of different kinds, performed by Dr. Morse, of San Francisco, on patients of both sexes, and varying in age from seven to fifty-six years. In every instance the anæsthetic acted with extreme rapidity, and repeatedly, after a few deep inspirations, such a degree of anæsthesia was attained that pain was no longer felt, although reflex action was still maintained. In cases in which deeper narcosis was required, further administration of the mixture always removed any tendency to struggling. Children and young subjects were rendered insensible in a remarkably short time, but with drinkers the administration lasted longer. In not a single case was any marked excitement observed. With slight anæsthesia no change took place in the pulse and respiration. In instances of deep narcosis the respirations were accelerated, and the pulse frequency was diminished. In many patients the face became congested, and covered by perspiration. After a state of incomplete anæsthesia, the patient came to at once when the administration of the mixture had been arrested, and after a more prolonged and deeper narcosis there was for some time a quiet sleep, which, however, did not resemble in any way the deep coma observed after the administration of ether or of pure chloroform. Invariably the patient, in recovering from the effects of the anæsthetic, became conscious at once, and did not suffer subsequently from headache, vomiting, or nausea."

Notwithstanding such favourable reports the mixture has not met with favour from either British or American surgeons.

One of the difficulties of chloroform anæsthesia results from the uncertainty of the quantity necessary to produce complete anæsthesia. I have had a patient who was with difficulty recovered from the narcosis produced by three drops of chloroform, placed on a piece of cotton wool, which was put into a hollow tooth; whilst on the other hand an elderly woman, from whom recently I excised a small tumour, required four drachms of pure chloroform to produce anæsthesia. On this subject Mr. William Martin Coates, of the Salisbury Infirmary, contributes a valuable article to the *Lancet*, of the 23rd of December, 1882. He writes—"By repeated trials I have found that, by means of Snow's inhaler, five minims of this anæsthetic (chloroform) followed by ten in twenty seconds, and in forty seconds by fifteen, and then fifteen every minute until the patient became insensible, and afterwards an occasional ten minims were sufficient in almost every case to produce and maintain complete anæsthesia; very rarely twenty minims were required. It was found that when fifteen minims were put into the inhaler every minute during the inhalation, all the chloroform had evaporated at the end of that time. . . . Although I have, during these twenty-four years, never been prevented administering it by extreme age or infancy, by chronically diseased heart, lungs, or kidneys, I have not had a death by chloroform. Considering that I have been Surgeon to the Salisbury Infirmary during all these years, and have had during that period a numerous *clientèle*, this evidence will not, I trust, be considered unimportant. . . . During these twenty-four years I have never refused chloroform to any patient in whose case pain was anticipated . . . Sometimes patients fancy that the mouthpiece of the apparatus will suffocate them; in such cases I sprinkle ten minims of the anæsthetic on a handkerchief, and when it begins to act return to the inhaler. . . . We all know that some

patients are prone to be rapidly and profoundly affected by mercury, opium, and chloral hydrate, &c.—I am certain that some, and not a few, are dangerously affected by the usual doses of chloroform. . . . A young woman of twenty-four years of age was completely narcotised by five minims of chloroform. . . .

"It has been said above that I have not in one instance refused to give chloroform because of diseased heart, feeling that indications of danger would declare themselves in time to combat them. Two illustrative cases have occurred in private practice during the last four weeks. One was a gentleman on whom I performed lumbar colotomy; his pulse was very feeble and intermittent. The other case was an elderly lady, with tricuspid insufficiency very marked. . . . The old gentleman was given chloroform after my method, and when the pulse dropped at all twenty minims of ether were put into the modified Snow's inhaler."

The same method was adopted in the case of his lady patient.

That chloroform is the most suitable anæsthetic in cases in which cardiac troubles exist is the opinion of many distinguished surgeons. Dr. M'Guire and Dr. Chisolm, and many other eminent surgeons, have had patients suffering from cardiac troubles put under the influence of chloroform for operation. Similar is the experience of Surgeon-Major Lawrie,[a] Principal of the Hyderabad Medical School, who gave the results of the experiments conducted by him, for the Government of the Nizam, on the effects of chloroform as an anæsthetic.

The Commission consisted of Dr. Hehir, Mr. Kelly, and Mr. Chamarette, and as their conclusions, which differ from those of the Commission appointed by the Royal Medico-Chirurgical Society, and that appointed by the British Medical Association, and also that of the Boston Society for the Improvement of Medical Science,

[a] British Medical Journal, 23rd of February, 1889.

are strongly in favour of chloroform, even in cardiac disease, it may not be uninteresting to give the report as it appears in the *British Medical Journal*:—

"Dr. Lawrie said the experiments which have been carried out by the Commission. . . were, in his opinion, the most important that had ever been made, and had conclusively decided a question which had been in dispute ever since chloroform was first introduced. There was no doubt that anæsthesia produced by chloroform was best measured by its effect on the breathing, and that when the administration was pushed beyond a safe point the breathing became embarrassed, and then stopped. The question in dispute was whether chloroform ever effected the heart directly or not, and this was important in its bearing on the way in which the administration of the anæsthetic should be conducted." To obtain evidence on this point "they killed with chloroform one hundred and twenty-eight full-grown pariah dogs, averaging over twenty pounds weight each. This does not represent a tithe of the experiments they actually performed, which really amounted to several hundreds, as they varied the dose and the method of administering the chloroform in every possible way, and tested the value of artificial respiration in nearly every case by reviving the dogs over and over again after the breathing had stopped, and before the heart ceased beating. What they found was, that no matter in what way it was given, in no case did the heart become dangerously affected by chloroform until after the breathing had stopped. This," adds Dr. Lawrie, "tallies exactly with my own experience. I have given chloroform as often, or oftener, than any man living, and have never had a fatal case, and I can state positively that in the 40,000 or 50,000 administrations I have superintended, I have never seen the heart injuriously or dangerously affected by it. I take no credit to myself in this matter—I have simply carried

out in India the principles Simpson and Syme practised and taught in Edinburgh."

In selecting an anæsthetic the surgeon must be guided by the case—there is no general anæsthetic. I believe that chloroform is the most generally useful; but there are cases in which—although the anæsthesia was produced by chloroform—it might with advantage be kept up by the use of ether, or the A. C. E. mixture.

If the anæsthetist is not familiar with the administration of chloroform it is unwise to allow him to give it. I have more than once had ether given simply because the anæsthetist had not been in the habit of administering chloroform. The anæsthetist accustomed to ether is apt to err, either by giving too much chloroform, or by giving it with an insufficient admixture of air, or by not giving enough of the drug, and stopping short of suspension of the reflexes. No person unaccustomed to the administration of anæsthetics should undertake the duty—their proper administration requires careful training and a proper knowledge of the agents for their efficient use. It is the want of proper training that has brought about a prejudice against chloroform—no active medicinal agent can be properly used by other than an educated administrator.

[a] The following statement from the *Pharmaceutical Journal* of the 6th June, 1889, shows how careful the anæsthetist should be in securing pure chemicals. Happily, in this country the chloroform manufactured by such firms as Duncan, and Flockart, and MacFarlane is always procurable, and, I need hardly say, always reliable :—"According to an investigation lately carried out by Professor Mentin, the newly-appointed Professor of Pharmacy and Pharmacognosis in Warsaw, chloroform is very frequently impure. For example, one specimen, obtained from a well-known Saxon house, and labelled 'cloroformum purissimum,' when 49 c.c. were evaporated, gave a residue weighing 0·0006 gram, consisting of fine large white needle-like crystals, of disagreeable smell, reminding one of rancid butter, insoluble in water, and darkened by hot sulphuric acid. Another sample, which is stated to have been manufactured from chloral, left a residue weighing 0·0011 gram, consisting partly of oily matter and

A knowledge of anæsthetic agents and their mode of administration is just as necessary as a knowledge of hypnotics. Students are trained to select and give hypnotics. Why do not the colleges insist on an equally careful training in the selection and use of anæsthetics?

Surgeons who recognise fully the great value of chloroform do not hesitate to acknowledge that it is not suitable for every case. Thus, chloroform is, in Dr. M'Guire's[a] opinion, an unsuitable anæsthetic in cases where there is a nervously weak heart, or where the weakness results from fatty degeneration, or from loss of blood or great anæmia from other causes, and he further adds, that "of all the elements of danger, to my mind, from chloroform, fear on the part of the patient is the greatest. If the patient is, so to speak, in mortal terror of the anæsthetic the heart is nervously weak, and the hazard to life is especially great."

The influence of chloroform on weak hearts is, however, con-

partly of crystals, having a sweetish aromatic odour of a disagreeable nature if inhaled for any time, and tending to cause stupour. The worst specimen, however, was one also obtained from a respectable German house. Of this 49 c.c. were taken and subjected to fractional distillation; '6·5 c.c. came over at 59° to 60° C., 30 c.c. from 60° to 61°, and 12·5 c.c. above 61°. The first 5 c.c. was turbid from the admixture of water. The residue weighed 0·0022 gram, and consisted of well-defined acicular crystals surrounded by a yellowish liquid. It had a most disagreeable odour of nitrobenzol mingled with tobacco, which, when inhaled, produced giddiness and headache. After forty-eight hours the smell of nitrobenzol passed off and was replaced by that of benzoic acid. When the residue was heated on a watch-glass it partly evaporated, the remainder turning brown and emitting a smell like that of burnt indiarubber.' It is not very wonderful that the surgeons who used this last sample for operating purposes found alarming symptoms arise in fully one-half of the cases. Professor Mentin says that none of the specimens came up to the standard of the Russian Pharmacopœia, which does not differ much from that of the German Pharmacopœia. It is interesting and gratifying to note that the sample which most nearly approached the standard was one manufactured in this country. The German specimens were mostly produced by the alcohol and bleaching powder process."

[a] The Choice of General Anæsthetics. Richmond. Oct. 1887.

sidered by Dr. Julian J. Chisolm[a] to be wholly beneficial. He writes:—"*Diseased conditions of the heart, regardless of kind*, may make this important organ particularly susceptible to syncopetic influences, when reflex action has full sway; hence we find violent emotional excitement a fruitful cause for mortality in the subjects of heart disease. Many such persons having to undergo painful surgical operations in former times, before the introduction of chloroform, suddenly collapsed with the first incision, and they *still die as of old when they are not properly protected by complete anæsthesia.* Should chloroform be freely given to patients with heart disease, regardless of kind, who must submit to painful operations for the cure of some surgical affection, *by its liberal use they are put in a condition of safety against all emotional and reflex annoyances*, without which they could not escape trouble.

"*I look upon chloroform as the strong bridge which will conduct patients suffering from serious heart disease safely over serious operations.* As a surgeon in large ophthalmic practice, I frequently am compelled to perform the most delicate and painful operations upon the eyes of timid patients suffering from heart disease in some one of its various forms. Cataracts occurring usually at an advanced age, most frequently between sixty and eighty-five years of age, are often associated with organic disease of the heart in patients enfeebled by senility. Prior to the introduction of cocaine, that wonderful local anæsthetic for eye-work, I never refused to give such patients chloroform; on the contrary, I urged its use. The only difference that I made in such cases over other patients was by exercising even more care in establishing the safe stage of complete anæsthesia through the liberal use of the drug."

The great advantages of chloroform are that it occasions no visceral troubles. It is true that in experiments on the lower

[a] Chloroform, the Best of Anæsthetics. Baltimore. 1888.

mammals its repeated use is said to produce fatty degeneration of the heart, a statement not supported by the experiments of the Hyderabad Commission, nor has any case of fatty degeneration resulting from its use on the human being, as far as I know, been published. When the chloroform anæsthesia has been recovered from no ill results follow. A few cases of hallucinations, as recorded above, have been noticed, but they are too few to affect the general rule.

Of ether Dr. Julian J. Chisolm writes:—"Kidney diseases are referred to as a very dangerous element to be anæsthetised with sulphuric ether, and many operators examine with care the urine of patients prior to administering ether as an anæsthetic. Bronchial troubles are also considered antagonistic to the safe administration of sulphuric ether, not directly, but indirectly. In such cases, after operation has been completed, and the resuscitated patient has been put to bed, a fatal pneumonia has developed, which follows too often the administration of ether to be considered a mere coincidence."

This statement agrees with that of Dr. Hunter M'Guire,[a] who writes;—"Clinical experience shows that, when the vapour of chloroform is withdrawn and consciousness returns, the patient is free from all danger from the anæsthetic. In ether, several minutes after the anæsthetic is taken away, and after all danger from the anæsthetic is supposed to have past, when all ether vapour we would think had escaped from the lungs, dangerous symptoms suddenly present themselves, from which the patient is with difficulty rescued, or even death itself takes place. Or, again, hours or even days after ether has been given, acute nephritis or pneumonia, directly traceable to the ether, occurs, threatening the life or causing the death of the patient."

[a] The Choice of General Anæsthetics. Richmond. Oct., 1887.

Vomiting and troublesome hiccough are also some of the after-effects of ether inhalation, and occasionally, especially in cases of laparotomy in women, mania has resulted from its use.

However safe ether may be as an anæsthetic, the list of cases in which it is unsuitable is a formidable one. Dr. Dudley Buxton,[a] who is a strong advocate for ether, enumerates the following cases in which it should not be used:—

"(*a*) In protracted operations about the mouth, jaws, nose, or pharynx, which necessitate the mouth and nose being uncovered. Since consciousness rapidly returns when the supply of ether is discontinued, there is not time for prolonged surgical procedure.

"(*b*) All operations needing the employment of the actual cautery, or lighted candles, lamps, &c., in the vicinity of the mouth, ether being highly inflammable, and when mixed with air detonating, so that the incautious bringing of the apparatus near a light may lead to grave consequences.

"(*c*) Persons who are suffering from bronchitis, and those liable to that complaint; the emphysematous (if the condition be very pronounced), and as a rule asthmatics bear ether badly, since it excites cough, and may clog the bronchial tubes with a quantity of excessive secretion.

"(*d*) In renal disease, when extensive, ether is said to induce suppression of urine, so that if given at all in these cases it should be with the utmost caution.

"(*e*) The vascular excitement to which ether gives rise contra-indicates its use, for persons whose arteries are presumably brittle, or in whom circulatory perturbation is like to be harmful. It is obvious that when cerebral hæmorrhage from rupture of an artery has once occurred, ether might, by increasing arterial tension, induce a repetition of so dangerous an accident.

[a] Anæsthetics: their Uses and Administration. 1888.

"(*f*) In infants and very young children ether sometimes produces great pulmonary trouble, from its irritating effects upon the delicate mucous membrane of the respiratory tract. However, with the exception of the conditions considered under (*e*), no hard and fast rule negatives the use of ether. Further, other anæsthetics may be contra-indicated, and then ether may be advisable, even in cases grouped under *a*, *c*, and *d*.

"(*g*) As ether always provokes rapid breathing and not infrequently coughing, it should not be used when these are prejudicial to the patient, or to the success of the operation.

"(*h*) The presence of brain tumours, intestinal obstruction, and cancerous tumours, is by some considered contra-indicatory of ether (Wood)."

Thus we find that if the respiratory, circulatory, urinary, and alimentary functions are normal, and that the patient is of middle age, ether is suitable; but supposing these conditions present, there can be no objection to chloroform.

Even in marked asthenic conditions, from whatever cause arising, complicated by any affection of the air passages, Dr. Frederick Hewitt recommends chloroform diluted with from one-fifth to one-eighth of pure alcohol as "the most appropriate anæsthetic to employ."[a] In operations on the brain or its membranes he considers chloroform has many advantages over ether. And in "Affections of the Respiratory Passages and Pleuræ,"[b] Dr. Hewitt writes:—"In this group may be included the following *obstructive conditions of the air-passages producing dyspnœa*—such, for example, as aneurism pressing on the trachea or main bronchi, tracheal stenosis, laryngeal disease with stridor, &c.; *advanced chronic bronchitis and emphysema*, with secondary cardiac changes;

[a] The Lancet. Vol. I., p. 1,013. 1888.

[b] Ut supra.

chronic pneumonia; phthisis in its middle or late stages; *pulmonary congestion and œdema* arising in the course of other diseases; *hydrothorax and pleuritic effusion; chronic pleural diseases*, with secondary lung changes; and *empyema*. In all the above-mentioned morbid conditions the patient's respiration becomes more or less seriously affected, and chloroform is the most appropriate agent for producing anæsthetic sleep in patients of this group. . . . . Cases of old-standing pleural disease, even though one lung be completely crippled, tolerate chloroform very well; in some cases there may be no thoracic expansion whatever, the breathing being wholly abdominal, and yet threatening symptoms are rarely met with when this anæsthetic is used. Whenever it is practicable, the patient should lie on his affected side, but I have known chloroform well borne even when patients have been lying the reverse way, with the affected side uppermost."

Of renal disease Dr. Hewitt writes:—"It must be borne in mind that most patients with Bright's disease suffer sooner or later with œdema, not only of the extremities, but also of the lungs and pleuræ; and such patients might, apart from their renal condition, be seriously affected by ether."

Reeves,[a] comparing the effects of ether and chloroform, declares that "the accepted doctrine that there is an essential difference between the effect of chloroform and that of ether on the circulation rests entirely upon experiment with animals. It is not in accord with clinical experience. Sphygmographic tracings show depression always with the former, but not always with the latter. But of ten carefully-taken tracings during surgical anæsthesia from ether, in seven there was no difference between them and the curves observed under chloroform."

Dr. Reeves is a warm advocate for ether in preference to

[a] Reference Hand-book of the Medical Sciences. Vol. I., p. 190.

chloroform; therefore a few abstracts from his article on anæsthetics may not be out of place. He writes:—"Careful study of recorded cases shows that death from ether does not differ materially from that caused by chloroform, the chief point being that it does not occur so frequently by failure of the circulatory organs. The following propositions may be safely stated:—1. As with chloroform, sudden death during operation has been often unjustly attributed to ether. 2. No statistics exist upon which can be based a statement of the ratio of deaths from ether to inhalations, or as to the relative safety of the two agents. 3. Death never takes place from inhalation of air too fully charged with vapour of ether, as is the case with chloroform. 4. Reason, experiment, and clinical experience concur in indicating that ether is the safer. 5. It remains an open question whether surgical interference during partial anæsthesia from ether is dangerous, as in the case of chloroform. 6. Death may take place under ether suddenly and by cardiac paralysis, the same as under chloroform. Clinical experience does not support the assumption that ether death is always by the lungs, and chloroform death always by the heart. This is true of animals under ordinary circumstances, but when the trachea is opened and pure ether vapour is carried directly to the lungs, death in them takes place by the heart, and that within a very short period of time. Death has thus been caused in dogs in sixteen seconds. Cases are on record in which sudden cessation of the heart's action took place under ether, and in which the death differed in no particular from a typical death from chloroform." And he adds that "in aged subjects a rapidly-fatal suffocative catarrh has sometimes followed the administration of ether." Need we be surprised that he adds—"Probabilities are favourable to the view that chloroform is safer than ether for the aged. He considers ether especially dangerous in cases of Bright's

disease—a fact which, he states, was first recognised by Dr. Emmet. For valvular disease of the heart he considers chloroform the better anæsthetic, but in cases of fatty degeneration he prefers ether.

In a recently-published lecture by Dr. J. William White,[a] to the graduating class of the University of Pennsylvania, he says:—"There is hardly a case in which ether cannot be given with safety, but there are certain classes of cases in which there is special danger. These are—1. Very old people with emphysema, fatty heart, hypertrophy or valvular disease of the heart. 2. Persons with marked tendency to weak heart action or syncope. 3. Persons with extensive lung disease, or with lungs greatly tied down by old pleuritic adhesions. 4. Habitual drunkards. 5. Persons who, as the result of alcohol, syphilis, gout, rheumatism, or old age, have marked evidence of extensive atheromatous disease."

Thus we see that the consensus of opinion on both sides of the Atlantic is that there are a large number of cases for which ether is unsuited as an anæsthetic; and omitting the cases of nervous patients and those who suffer from cardiac asthenia, there are no cases in which ether may be used that chloroform is not equally suitable.

The death-rate from chloroform is high; it is calculated as one in 525 administrations, a rate which appears too high in the presence of the following statistics, which were collected by Dr. Chisolm; and although some object to them because they are old, yet I fail to see how facts are invalidated by age:—"In the Edinburgh University two deaths have been attributed to chloroform, which, according to Ker, is one in 36,500 administrations. Grant wrote—'I have seen chloroform given in some thousands of cases during upwards of twenty years, both in

[a] Medical and Surgical Reporter. Vol. LX. No. 10. Philadelphia, Pa. March 9th, 1889.

hospital and private practice, without a single death, or even an approach to a fatal termination.' Kidd, of London, had seen it administered upwards of 10,000 times, and had seen no fatal cases, either in his own case or in that of his friends. Dr. Bardeleben, of Berlin, had participated in its administration to over 30,000 patients before meeting with a death from chloroform. The French surgeons in the Crimea reported 30,000 cases of chloroform administered and not one fatal issue. In the English army in the Crimea chloroform was administered 12,000 times with one single death reported as attributed to it. Richardson had seen it administered 15,000 times before he met with his first fatal case. Billroth, of Vienna, had administered chloroform 12,000 times before he met with his first accident. Clover has recorded 3,000 without a single death."

In the Federal Service during the Inter-States War, chloroform was administered 80,000 times. In 37 cases fatal results have been ascribed to its use—a proportion of one death in 2,200 administrations.

In the Confederate Service, Dr. Chisolm writes, "Chloroform was exclusively used in a great many thousand operations without a death, as far as I am aware of or have been able to ascertain, after diligent inquiry among leading surgeons in the army."

Dr. Hunter McGuire, of the Stonewall Jackson Corps, records 28,000 administrations without a single death; and it is reasonable to suppose that Longstreet's corps had an equal number, as would also Joe Johnson's army. Dr. Chisolm had not a death in 10,000 administrations. Altogether he collected "an array of over 300,000 administrations of chloroform with 43 deaths, even attributing them all to idiosyncrasy, which calls for a most unbounded charity, and we have only one death in 7,000 cases. Can any stronger proof of the excessive rarity of the fatal idiosyncrasy in

chloroform be needed?" To these may be added the 50,000 administrations superintended by Surgeon-Major Lawrie without a single death; and when we, after reading these records, come on a percentage of one death in 500 administrations, nothing but unbounded charity can cause us to place the whole blame on chloroform.

CHAPTER XIII.

More Madden on the Use of Anæsthetics by the Ancient Irish—Hypnotic of Philostratus—Mandragora used by Himilco.

When the first contributions on anæsthetics were sent to the press, I was not aware of Dr. More Madden's very interesting article entitled, "Notes on the Probable Employment of Anæsthetics in Ancient Times, especially in Scotland and Ireland," which appeared in the *Dublin Journal of Medical Science* for December, 1874.

Dr. Madden, by a quotation from the "Life of Kentighern, or St. Mungo, Patron of Glasgow, shows that the Scotch were familiar with anæsthetics, and he concludes that the principal ingredient in the Scotch "*potu oblivionis*" is mandragora, which, according to a materia-medica of the twelfth century, translated for Dr. Madden, by Mr. O'Langan, of the R.I.A., was in use in Ireland as an hypnotic and pain-killer, from which fact with some others, he very reasonably concludes that the ancient Irish used anæsthetic remedies.

The "*potu oblivionis*" resembles the hypnotic described by the rhetorician, Philostratus of Lemnos, who flourished in the third century, in his philosophical romance "The Life of Apollonius of Tyana,"[a] which was written at the request of Julia, wife of the Emperor Severus. It is as follows, to wit: "There are also certain medical preparations which men have discovered for producing

[a] The Life of Apollonius of Tyana. Translated from the Greek of Philostratus, with notes and illustrations, by the Reverend Edward Berwick, Vicar of Lexlip, in Ireland. 1809. Vol. XXXVI., p. 115.

sleep, of which, if they drink, or with which if they anoint themselves, they sleep stretched out as if they were dead."

The following passage from Polyænus, Strag. V., 10, 1, tells of the advantage taken of the hypnotic action of mandragora. "Himilco, the Carthaginian, knowing the fondness of the Libyans for wine, having drugged many jars of wine with mandragora, and laid them down in the suburbs, on their advance, retired into the city, as though unable to resist the force of their onset, while they were not only over-elated with having, as they thought, shut up the Carthaginians within the walls, but finding the jars greedily drank off the wine to excess, and were forthwith overtaken by the heaviest sleep."

CHAPTER XIV.

General Rules for the Administration of Anæsthetics.

Anæsthetics are better borne in the morning than later on in the day.

An anæsthetic should on no account be administered by the inexperienced or carelessly.

"Under no circumstances is it desirable for a person to give an anæsthetic by himself."

"It is not advisable to give an anæsthetic after a long fast, or soon after a meal, the best time for its administration being three or four hours after food has been taken."

The patient may take a broken-up egg, or a little milk, or, if depressed, he may take a little brandy, whiskey, wine, or ammonia, before commencing the inhalation.

"Provision for the free admission of air during the patient's narcotism is absolutely necessary."

A patient about to be placed under the influence of an anæsthetic should have every impediment to respiration and circulation removed: belts, corsets, and such like, taken off.

Whilst on the operating table the patient should be lightly, loosely, and warmly clad, and, if necessary, a hot water apparatus should be placed to the feet.

During the administration of the anæsthetic, the patient should, if possible, be placed on his back, with his head slightly raised on a pillow.

The room in which the anæsthetic is being administered, should

be kept perfectly quiet, and all instruments or apparatus likely to frighten the patient should be carefully kept out of sight.

Before beginning the administration of the anæsthetic, the proper means for the resuscitation of the patient should be examined and placed in readiness.

An apparatus is not essential to safety, if due care be taken in giving the anæsthetic.

Few, if any, persons are insusceptible to the influence of chloroform, the time and the amount necessary to produce anæsthesia varies with age, temperament, habits and idiosyncrasy.

Inhalation should not be commenced until the patient's mouth is examined for foreign bodies: false teeth and soforth, which should be removed. This is especially desirable in the case of children, who often have sweets, or buttons, or some foreign body in their mouth.

From the commencement of the inhalation a competent assistant should watch the pulse, respiration, and face of the patient.

Remember that death occasionally takes place very suddenly during etherisation, even in cases in which the ether has been taken freely for some time.[a]

[a] Report of a Death under Ether (*Phil. Med. and Surg. Reporter*, 1st June, 1889), by A. W. Ransley, M.D., Visiting Surgeon to the Philadelphia Hospital.—The patient, D. A., thirty-six years old, was admitted into the surgical wards of the Philadelphia Hospital. The diagnosis was: Coxalgia. On taking charge of the wards on the 1st day of April, 1889, I found the patient suffering extreme pain. He was anæsthetised and examined, and extension was applied. I had the man etherised on May 18. The condition of the patient did not contraindicate the use of ether or the performance of the operation. The patient acted well under the ether, the pulse being moderately strong and regular. The patient's countenance suddenly changed: his face became cyanosed; his respirations became shallow and gasping; his heart fluttered, and death speedily ensued. Although everything that could be done for the patient was resorted to, the man died almost as if struck by lightning. It took fully twenty-five minutes to get the patient under the influence of the ether, but the operation was performed in a very short space of time—fifteen minutes—so that the

The anæsthetist should not allow his attention to be distracted from his special duty by any incident of the operation.

Chloroform, and its compounds, should be inhaled slowly, and with a free admixture of fresh air.

"Slow etherization possesses no advantages, and is indeed positively harmful, by prolonging the stage of delirious excitement."—(Buxton.)

Under no circumstances should the anæsthetic be pushed too quickly or too far.

The occurrence during the administration of an anæsthetic of sudden pallor, or sudden lividity of the patient's countenance, or embarrassed breathing, or sudden failure or flickering of the pulse, indicates danger, and calls for the immediate withdrawal of the anæsthetic and the admission of fresh air, until breathing and circulation become normal.

Should the patient appear likely to vomit whilst inhaling the anæsthetic, turn him on his side and withdraw the anæsthetic, until the nausea disappears. If vomiting occurs during the anæsthesia, turn the patient's head, with his face down, over the edge of the table, and, when the vomiting ceases, remove any ejected matter that may be present from his mouth, and sponge the mouth it out with water.

Should the patient, as some do—especially drunkards—become excited and struggle, holding his breath until the veins become turgid and prominent, withdraw the anæsthetic until the breathing becomes normal.

Chloroform, ether, and their compounds, may be inhaled either

death occurred about forty minutes after the etherisation was begun. Ten fluid ounces of Squibb's ether had been administered, by means of a cone formed with a towel, an opening being left at its apex, by one of the residents of the hospital. The previous etherisation was without alarming symptoms, and the last gave rise to no anxiety until immediately before the fatal termination.

by the "open" or the "closed" method. The inhalation of the anæsthetic from a folded towel, napkin, or a sponge, is known as the "open" method. The "closed" method implies the use of a special apparatus. Many surgeons, particularly those who use chloroform, prefer the "open" method.

A hot sponge, enclosed in a conically-folded towel, I have found to form an excellent and reliable method for etherisation.

In chloroformisation with a cone-shaped towel, care must be taken to have the apex of the cone open, and not to add too much of the anæsthetic to the towel. Approximate the towel slowly to the patient's face, being particular to insure a free admixture of atmospheric air with the chloroform vapour.

The simpler the apparatus for chloroformisation the better. An excellent one may be made with a little copper wire and piece of flannel, as follows:—Form a circle of copper wire, sufficient to pass over the patient's nose and mouth, and to two diametrically opposite points of it attach a semicircle of the same wire, whose plane is at right angles to the plane of the circle (for example, the handle of a bucket); over this is stretched a fold of thin flannel, on the convex surface of which the chloroform should be dropped. The patient cannot be alarmed by the appearance of the apparatus. It insures a free admixture of atmospheric air; and as the chloroform is added drop by drop, the danger of an overdose is infinitesimal.

The excessive vomiting which sometimes follows on the recovery of consciousness from anæsthesia, especially etherisation, may be cured by giving "the patient very hot water to sip, or by the administration of an eighth of a grain of morphia in pill, with, perhaps, a little cocaïne."—Craig and Cathcart.)

Until the whole effects of the anæsthetic have passed off, the patient should be carefully watched by a special nurse. Anæsthesia is occasionally followed by hallucinations and mania.

Etherisation is unsuited—

For young children and old persons.

For those who suffer from bronchial, pulmonary, or renal disease, or atheroma of the arteries, cerebral congestions, or cerebral tumors.

It is unsuited for operations on the nose, mouth, tongue, jaws, palate, pharynx, brain, and intestines.

Midwifery operations.

For all those requiring the galvano or the actual cautery.

COCAÏNE.

Cocaïne requires no special apparatus for its use. A 10 per cent. or 20 per cent. solution may be brushed over mucous surface, or from two to six drops may be injected hypodermically. Cocaïne occasionally produces unpleasant results—giddiness, cardiac irregularity, delirium, retching, and collapse.

TREATMENT OF COCAÏNE NARCOSIS.

Give a little brandy and water, or sal-volatile.

Inhalations of nitrite of amyl, or ammonia.

Place the patient in the recumbent position.

TREATMENT OF ANÆSTHETIC NARCOSIS.

Remove the anæsthetic.

Invert the patient.

Admit fresh air.

Seize the chin of the patient, and draw it forward (Chisolm).

Give inhalations of amyl nitrite.

Apply ammonia to the mucous membrane of the nose.

Give hypodermic injections of ether.

Insert ice into the rectum.

The following suggestions have also been made :—

Draw out the tongue with a ring forceps.

Use artificial respiration.

Bleed from the external jugular or median cephalic vein.

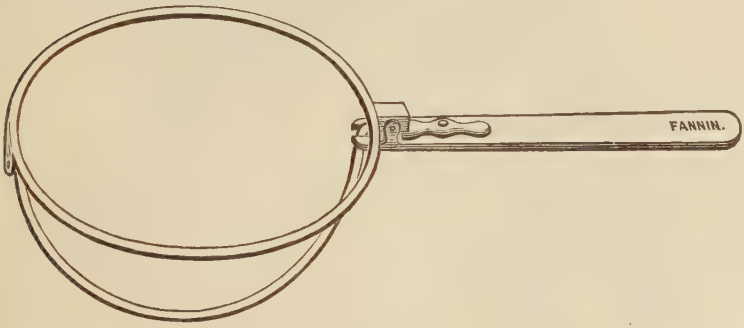
Use forced inspiration.

Oxygen gas inhalation.

Galvanise the diaphragm and phrenic nerve.

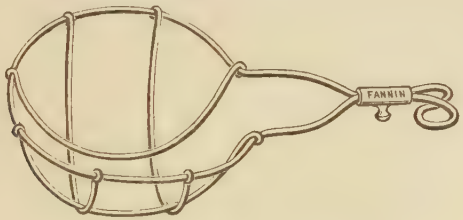
Acupuncture of the ventricle.

SOME OF THE MORE USED APPARATUS IN THE "CLOSED" METHOD.



SKINNER'S CHLOROFORM APPARATUS.

This apparatus consists of a light metal frame-work, over which a thin cloth is stretched, on the convex surface of which chloroform is added drop by drop. Using ordinary care, an accident with this apparatus is almost impossible. An overdose of the anæsthetic cannot well be given, and there is a due admixture of atmospheric air insured by using thin cloth.



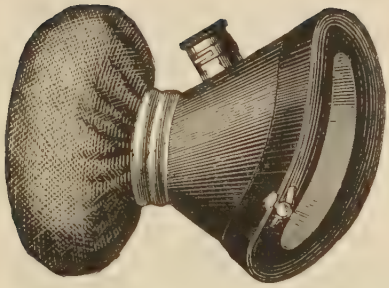
ESMARCH'S APPARATUS.

Almost identical is Esmarch's apparatus, which, however, by the addition of the hook (*a*), can be attached to a band encircling the head, and thus leave the anæsthetist's hand free to watch the radial pulse. It does not, however, insure as free an admission of atmospheric air, and is, consequently not so safe as Skinner's.

CLOVER'S PORTABLE ETHER INHALER.

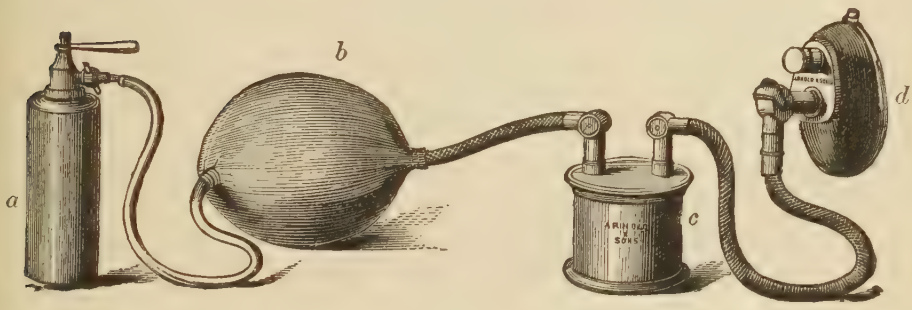
This convenient and efficient apparatus is the most generally used for the purpose of etherisation. It consists of a face-piece (*a*) attached to which is the ether and hot water chamber. An indicator (*b*), marking from 0 to 3 and F, successively, as the ether chamber is revolved, tells the varying admixture of atmospheric air. When the indicator points to 0 on the dial (*c*), the patient is breathing no ether vapour; but when F is reached, the patient is breathing ether vapour undiluted by atmospheric air.

The air-bag (*d*) is not fitted to the apparatus until the patient has breathed through the face-piece a few times, and even then ether inhalation should not be commenced until the patient has gained confidence by breathing atmospheric air several times through the apparatus. When complete anæsthesia has been produced, the percentage of ether inhaled may be lessened.



ORMSBY'S ETHER INHALER

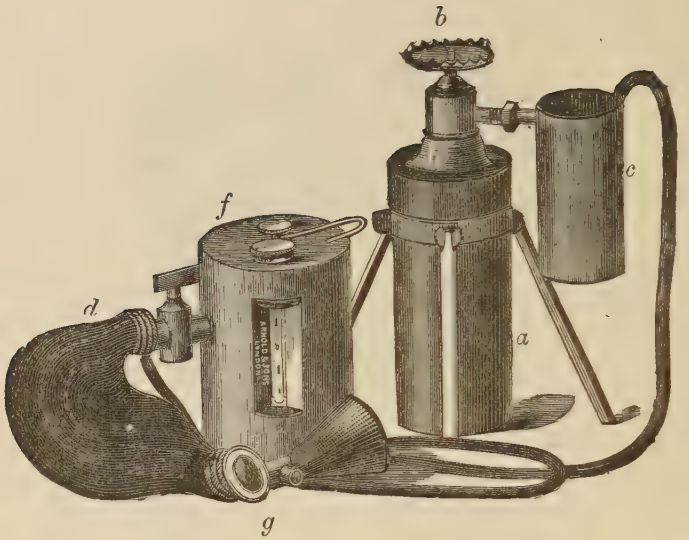
Essentially consists of a wire cage, containing a sponge on which ether is poured. A face-piece and an air bag are attached to the cage. The apparatus has been in use in the Meath Hospital, Dublin, by Mr. Ormsby's colleagues, for some years past.



NITROUS OXIDE APPARATUS.

The nitrous oxide apparatus of Messrs. Arnold & Sons is, perhaps, the most simple before the the profession, and its efficiency is attested by many competent anæsthetists.

It consists of a nitrous oxide bottle (*a*), a rubber bag (*b*), a hot water chamber (*c*), and a face-piece (*d*).



CLOVER'S ETHER AND NITROUS APPARATUS.

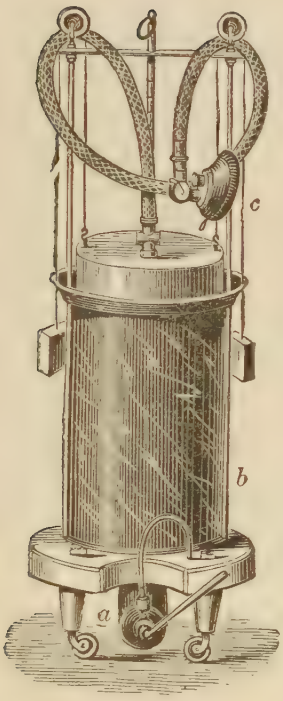
This apparatus, which is the most used, and, for its especial purpose, the most satisfactory, consists of an iron bottle (*a*) containing nitrous oxide. It is supported on a tripod, and closed with a screw stopper, the upper surface of which is toothed (*b*) to give a firm hold to the anæsthetist's foot, so that by a movement of his foot he can turn the screw, and so liberate or cut off the gas. Attached to the iron bottle is the hot water chamber (*c*), through which the gas passes into the tube, which conveys it to the Cattlin bag (*d*).

Passing the gas in cold weather through hot water, there is no risk of the gas freezing.

To the Cattlin bag is attached the face-piece and the ether holder (*f*), to the latter of which there is a stop-cock for, when necessary, cutting off the ether supply.

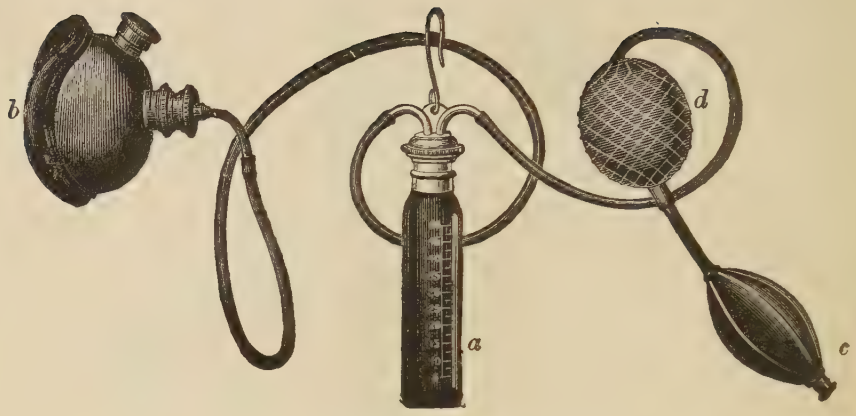
The proportionate quantities of ether and nitrous oxide are regulated by an apparatus (*g*).

The apparatus is not a complicated one, and its use is easily learned.



BARTH'S NITROUS OXIDE GASOMETER.

This apparatus is used in large hospitals where nitrous oxide anæsthesia has to be very frequently produced. It consists of a nitrous oxide bottle (*a*), which is connected by a tube with the gasometer (*b*). From the gasometer a rubber tube conveys the gas to the face-piece (*c*).



JUNKER'S INHALER.

This apparatus, which is the one used by Dr. Richardson and Sir Spencer Wells for the administration of methelyne, consists of an anæsthetic bottle (*a*), which is connected by rubber tubes to the face-piece (*b*), and an air bellows (*c*), to the latter of which is attached an equalizing rubber ball (*d*), covered with netting, to prevent over-distension.

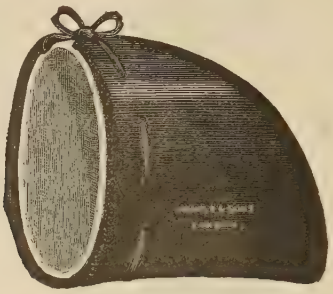
The anæsthetic bottle is graduated, so that the amount of the anæsthetic consumed is known. To the stopper of the bottle there is a hook attached, by which it may be hung from the anæsthetist's coat.

Dr. Dudley Buxton has improved the apparatus by substituting a foot bellows for the hand one.

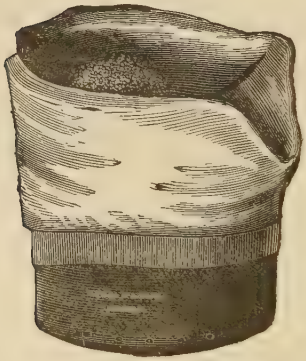
SYMON'S CHLOROFORM DROP BOTTLE.

BLOXOM'S CHLOROFORM DROP BOTTLE.

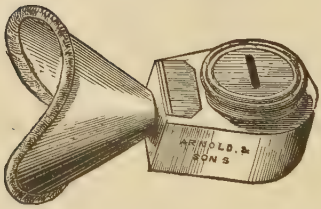
The following apparatuses, not being so frequently used, do not require special mention :—



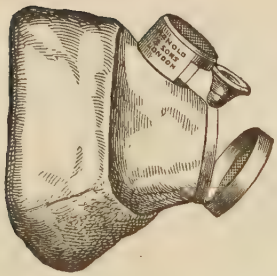
SKINNER'S ETHER INHALER.



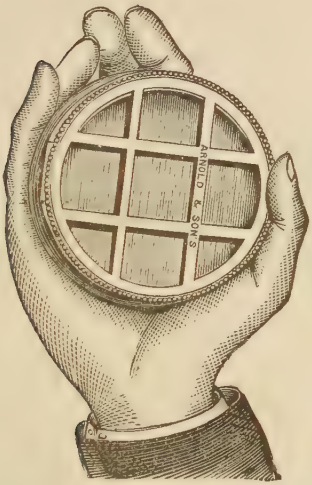
RENDLE'S ETHER MASK.



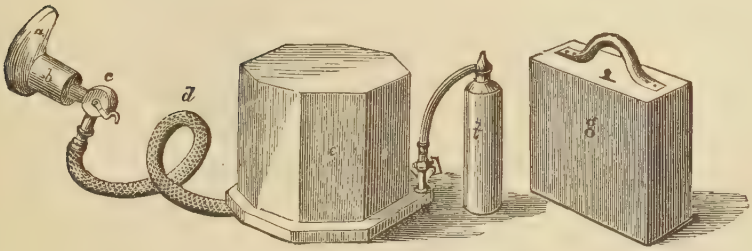
MURPHY'S CHLOROFORM INHALER.



GIBSON'S CHLOROFORM INHALER.



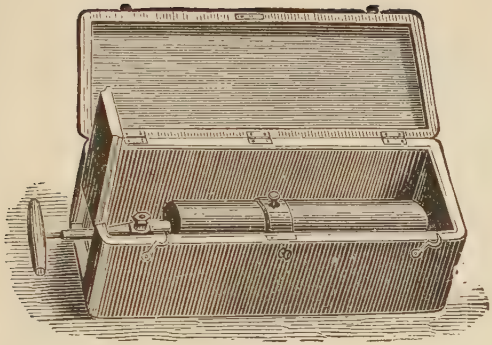
MULLANS'S CHLOROFORM INHALER.



EDWARDS' NITROUS OXIDE APPARATUS (ARNOLD).

SNOW'S CHLOROFORM INHALER.

ANGOOE'S ETHER INHALER.



LIQUEFIED NITROUS OXIDE BOTTLE (ARNOLD).

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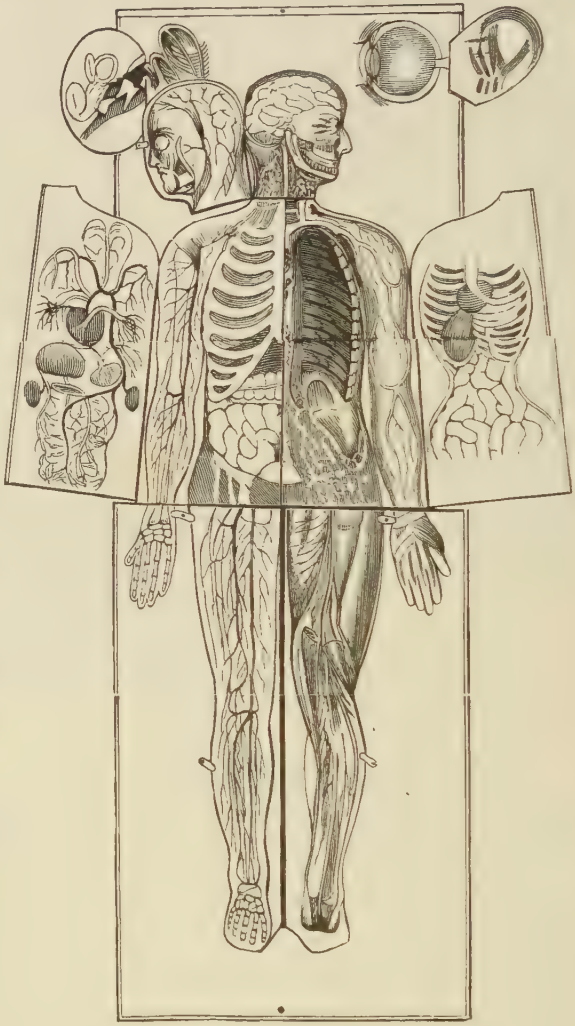

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